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Foreword

The author began his career in teaching, research and service in economics in 1968 with the completion of his PhD at the University of Illinois (Urbana-Champaign). At Duke University his first academic appointment was as Assistant Professor of Economics in 1969. Two years later he moved to Harvard for a joint appointment in Economics, Law and the Development Advisory Service, (later the Harvard Institute for International Development). He returned to Duke as Professor of Economics and Public Policy in 1984, and later became Dean of the Graduate School and the Dean of Arts and Science.

In 1993 he was selected as President of Rice University, and served in that position until mid-2004. Since then he has served as University Professor and Zingler Professor of Economics at Rice. And, in 2015, he was conferred the title of President Emeritus of Rice University.

This is not his first textbook in Economic Development. In 1983, he and three Harvard co-authors completed the first edition of Economics of Development. The textbook was known as the Gillis, Perkins, Roemer and Snodgrass text for the first five editions.

The present textbook bears scant resemblance to that textbook first co-authored with Harvard colleagues over 30 years ago. Over that period, I have had ample opportunity to reflect not only on my own research, teaching and field work, but the vastly changed circumstances facing poorer nations.

The present book reflects, among other things, my experience on the ground with economic development in nearly 30 nations. This includes very substantial experience in Indonesia over the period 1971-2003, Colombia (1967-1985), Bolivia (1975-1981), Ecuador (1980-84), Ghana (1968-71), Vietnam (2005-2014) and North Korea (2008-2014). I have also benefited from having worked on economic development issues in Panama, Honduras, Mexico, Surinam, Zambia, the Soviet Union (before 1990), China (several occasions from 1988-2005), Pakistan, Bangladesh and Thailand.

Since stepping down as President of Rice in 2004, I have taught a senior level Economic Development course every year save 2005. The course covers two semesters. This collection of works is derived mainly, but not wholly, from my class notes.

Now Versus Then

In the early eighties, the conventional wisdom in economics (and demography) was that the world was facing a disastrous population explosion. But owing to the rapid, and unforeseen declines in fertility in almost all regions of the world save the Middle East, we now face in many nations, including formerly poor ones, a population implosion.

Fifty years ago, real per capita income in China was barely above US$100. By 2013, per capita income in China (properly measured) was about US$7,500. This amounts to a 75-fold increase in less than 3 generations — unprecedented in world history.

Fifty years ago, the U.S. was the largest economy in the world. It remains so, but not by much. China now has the second largest economy.

The third largest economy—to the surprise of many—is India, which began strong growth only after 1982.

Ten years ago, the U.S. was the largest emitter of greenhouse gases. By 2014, the U.S. was in second place in this category, as China was then responsible for nearly twice the levels of U.S. emissions.

The above is by no means an exhaustive list of the remarkable changes in recent experiences with economic development worldwide. Others would surely include the rapid spread of globalization (both economic and otherwise), a stronger worldwide focus on environmental issues, the collapse of communism in China, Russia and Vietnam, notable increases in mobility of capital across natural borders, the rapidly changing roles of foreign investment and in economic development, and much more.

This collection seeks, it is to be hoped not vainly, to bring into focus all of these marked changes in prospects for economic development in over 120 nations traditionally-but not always accurately-referred to as emerging nations.

ECONOMIC DEVELOPMENT IS ABOUT ALL OF ECONOMICS

Economic Development is about all of economics; Micro, Macro, Trade, Public Finance, Monetary Economics, Econometrics, Environmental Economics, Human Capital, and much more. Economic development is mainly concerned with developing countries. These are now called “emerging” countries. Lately, concern has also focused on “submerging” countries such as Greece, Portugal, Spain and perhaps (we hope not) Italy and France. However, chapters in this book do draw a large number of lessons from now developed nations, such as U.S., Japan, Germany and Australia.

The Approach of This Book

Primary focus - using the economics you have learned.

A major theme of this book is that there is no economics for Europe and another for Africa — there is no economics for the U.S. and another for Latin America.

- The author’s half-century of experience in 30 nations from the U.S. and Canada to Europe, East Asia, South Asia, Mid East, Africa and Latin America has led him to this view.
- Understand then, that we do well to use the same “good” economics for rich and poor nations, rather than the “not-so-good” economics that has guided North Korea, the old Soviet Union, India before 1980s.

But, one thing that many economists forget or ignore (or don’t know):

- We must always recognize that different institutional settings and different cultural traditions in different countries require resourcefulness in the use of “good economics”.
- What works well in some countries, may not work so well in another.
- Economics does not by itself explain everything about the past, present and future of either developed or emerging societies.

A Caveat for the Reader

The study of economic growth and development involves complex issues involving almost all subfields of the discipline of economics, including not merely micro and macroeconomics, but public finance, the economics of education and public health, monetary economics, international trade as well as demographic economics, and environmental economics.

Readers who expect a neat, compartmentalized approach to growth and development will not find it in this collection, because the topics presented are tightly inter-related.

The concept of human capital and its implications for growth illustrates this point in boldface. Human capital formation, especially in the 21st century, is inextricably linked not only to education and public health, but technological change, fertility, women in economic development, income distribution, institutional change and even international trade. For this reason, human capital formation is covered not in one or two chapters, but is interspersed in multiple chapters through the book. This will be especially obvious in the first eight chapters after this one, where human capital is featured most prominently. Readers searching for comprehensive treatment of this important set of topics in one of two chapters will search in vain.

The Aims of this Book

- It is NOT for those with a narrow view of what economics is all about.
- It is NOT for those who shrink from policy applications of “good” economics.
- It is NOT for those who are economic determinists.
- It is NOT for those NOT interested in real world examples of economics in action, both when it succeeds and when it messes up.
- This is NOT a book about model building, but we will examine models.
- This book IS for those who find economics useful, and even satisfying.
- The book IS for those seeking to understand a very rapidly changing global economy. Example: There have been more changes in world economies in the past decade than in the previous four decades.

- This book **IS** for those who are open to the use of both market and governmental mechanisms for rectifying and sometimes resolving — major problems in sustainable growth, poverty reduction and economic opportunity.
- Finally, readers will benefit more from the book if they also know and appreciate **HISTORY**.

Throughout, we will be concerned about two main questions:

#1. How countries can achieve economic growth over long periods of time, especially economic growth that is as sustainable and supportive as possible of clean environments and the interests of future generations.

#2. The effects of economic growth on income distribution, health, longevity, role of women, population growth and poverty.

The record of the past century is clear regarding several matters:

- Countries that do not achieve sustained economic growth also do not do well in protecting air and water quality, or in reducing income inequality.
- The implications of the long run. Nobody, including economists, understands how to promote short and medium-term economic growth. The economic profession lacks this knowledge— growth is all about the long-term.
- Attaining high long-term rates of economic growth is difficult, and is rarer than commonly thought. Example: A commission headed by Nobel Laureate Economist Michael Spence found that in 2008, only 2% of countries have ever experienced long term growth (growth over 25 years) above 5% per capita (in real terms). However, about one quarter of all countries have had transitory episodes of growth in excess of 5%.

One should not be dismayed by these numbers. Due to compound interest, a 5% growth rate economy doubles in size every 15 years – less than a generation.

Good policies — fiscal, monetary, trade, exchange rate, education — have resulted in growth rates of 2-4% over very long periods in several countries, especially in East Asia.

Note:

What does this mean?

Consider growth over a 50 – year period in the following scenarios.

Country A:

With GDP of 100 in the year 2000. If country A grows by 1% in real terms annually, its real GDP will be 164 in 2050 (with compound growth) (GDP 1.6 times higher in 50 years).

Country B:

Also with initial GDP of 100 in the year 2000. If B grows at 2 1/2% annually, its real GDP will be 344 in 2050 (3.5x).

Country C:

Also with initial GDP of 100 in year 2000. If C grows at 4.00 % annually, in 2050 its GDP will be 711 (7x).

The Point:

While 5% long-term growth is difficult to sustain, 4% growth, or even $2^1/_2$% growth is attainable and well worth pursuing.

These differences matter mightily for poverty reduction, health, the environment, and the role of women in society.

Those who advocate low growth in poor countries are advocating perpetual income inequality and poverty, the likes of which existed Zambia, Zimbabwe, North Korea, and Burma before 2010.

Note:

What of growth in the past five decades?

Fortunately, Developing Nations’ share of World GDP has been growing steadily over the past 50 years, from less than 25% in 1960 to 50% by 2013.

- From 1973-1985, rich nations had a 72% share of World GDP, while Developing nations had 21%.

- Since 2008, rich nations had a 58% share of World GDP, while Developing nations had 40%!
- In 2013, Developing nations had a share of World GDP that exceeded 50% for the first time.
- Fifty Developing nations saw their World GDP DOUBLE over the past five decades.

The Early Beginnings of Growth

Using economics well is much easier when historical perspectives are brought to bear on the study.

Let's begin with the beginning. Stone Age conditions were clearly not conducive to economic growth. Economies, such as they were, largely supported a loose collection of hunter-gatherers and nomads. Things began to change with the onset of the Bronze Age. Indeed, one could argue that the beginning of economic growth and development date from the early Bronze Age in about 3,200 B.C.

The Bronze Age, which ended in about 1000 B.C.E., featured the first use of tin, which was melted with copper to form bronze, used initially for weapons, ornaments and utensils. (Bronze is much harder than copper).

Significant international trade dates from about 1200 B.C.E., when the Phoenicians sailed 3,000 miles to Cornwall, in the British Isles, where they first traded pottery and salt for Cornish tin.

The Phoenicians were not interested in conquest, only commerce. Later, however, the Romans were interested in both. A thousand years after the first Phoenician ship set sail for the British Isles the Romans transported tin for making bronze from the “Ding Dong” mine in Cornwall, across the English Channel and then overland back to Rome. Cornish source tin was to dominate world trade for the next two thousand years. The last Cornish tin mine was shut down only in 1998.

From the end of the Bronze Age we proceed to the reign of Alexander the Great of Macedonia in 350-320 B.C.E., and continue through the age of Heronas of Alexandria in 2nd Century C.E. and the rise of the Roman Empire.

The Dark Ages followed, at least in Europe: from 476-900 C.E. with devastating human and economic costs. The Middle Ages, from 900 C.E. to 1400 C.E., were marginally better economic times, but it took the industrial revolution (1820) to begin to make a real difference in economic growth worldwide.

This collection gives short shrift to Rome, the Dark Ages and the Middle Ages, because there is so much else to cover. Instead, our focus is mainly on the 20th and 21st Centuries. This means that we will not be able to discuss in any detail some fascinating episodes in the early history of economic development. What is missed by not studying growth and development in ancient and early modern time?

Example:

We will miss the opportunity to speculate on what might have happened to civilization if one of the great inventions of Heronas of Alexandria in 93 A.D. had NOT been lost to history for nearly 1,800 years.

Heronas, a Greek mathematician, invented a steam engine nearly 1,600 years before Lycoming and Watt introduced steam into Britain. His hand-pumped engine opened and closed temple doors. Here is one of the first of many instances in history where religion retarded technological growth.

Few were ever aware of Heronas' invention because the priestly class in Egypt wanted the faithful to believe that the gods, spirits and magic powered opening and closing of the temple doors.

Alas, the secret of steam was lost for centuries after the library of Alexandria was destroyed 400 years after Heronas' death (rediscovered on the island of Iona centuries later).

And because we focus primarily on economics in the 20th and 21st Century, we will be unable to explore some fascinating two-way interactions between economic development and biology.

Example:
Consider an ancient technological innovation that led to an increase in human brain size. That innovation, according to the archeological record, occurred about 800,000 years ago. It was the discovery of the efficiency of using fire in cooking, especially for meat (sorry vegans). With this discovery, prehistoric homo-sapiens garnered substantially greater nutritional value from their hunting activities. Why? The invention of cooking makes more nutrients available from foodstuffs than from uncooked food. This gave rise to an expansion in the brains prefrontal cortex. This expansion of brain matter allowed the emergence of homo sapiens.

Another result was improved health, and improved brain development especially in early life.[footnote]

See *The Economist*, May 31, 2014, p.71

After this innovation, the fossil records for homo-sapiens shows —during the middle stone age —a large and sudden increase in brain size, conferring obvious advantage on humans relative to other primates.

Example:
Another example of feedback between biology and economics.

In 1840s-1850s, who were the tallest people on earth?

- Nordic People?
- Teutonic People?
- Celtic People?

No, the Plains Indians of North America, including such tribes as the Sioux and Shoshone.

We know this from comparing skeletal records across continents.

Why were the Plains Indians so tall? The answer is the reverse of reasons for short stature in very poor nations.

Answer: Good Health and Diet:

Health:

Moreover, a study of Northern European economic history in 1700-1850 you would reveal the almost complete inattention to personal hygiene and proper human waste disposal. Men wore wool pants unwashed for weeks. Think about it. There was raw sewage on the streets and in the ditches of London. As a result, diseases were rampant, life expectancy was low, the growth of children was stunted, and brain development was retarded.

Not so with Plains Indians in 1800s. As a nomadic people in a land then largely unsettled and underpopulated, the Plains Indians moved often from place to place, so that they never, as it were, “fouled their own nests.”

Diet:

Between 1400-1850, vast buffalo herds roamed areas from the Texas Coastal Plain all the way up through Canada.

With plentiful protein, the diet of Plains Indians was conducive to rapid early growth, from infancy to adulthood. These two factors, many believe, account for the relatively great height of these Indians.

Sadly, we have quite recent examples of the effects of economic strategies leading to poor diet, which leads to stunted physical stature.

For example, North Korean youth aged between 18-30 in 2010 were several inches shorter than ethnically identical South Koreans, largely because of malnutrition stemming both from famines and floods as well as disastrous agricultural policy.

Why study economic growth and the growth process we call economic development?

Concern for the human condition over time requires a focus on what "growth and development"means for:

1. Longevity and quality of life
2. Female participation in the economy
3. Societal health
4. Societal aggression
5. Humans in the environment: especially the feedback between humans → and the environment and vice versa
6. Poverty of billions.

What matters most for persistence of poverty? Lack of poverty eradication? (Sustained growth?)

In the longer term:

- Some say climate (Jeff Sachs etc.)
- Some say limited availability of natural resources
- Some say culture — work ethic
- Some say bad government policy
- Some say lack of investments in physical capital
- Some say lack of investment in Human Capital

To the author, most of these are important secondary factors. Climate has affected economic development divided. Witness French verses Bangladeshi development, or temperate zones versus the tropics. Climate may in fact be particularly important in affecting economic growth in some tropical nations. Recent research indicates the role of temperature and rainfall may be significant in both the short and long-term in Sub-Saharan Africa. The impact of temperature is especially evident, whereas the role played by rainfall is less so. And because African economies appear to suffer significant damages from weather shocks, any trends toward

increasing global warming may lead to particularly heavy burdens on Sub-Saharan Africa[footnote]
See Matteo Lanzafame, M. (2014, February), “Temperature, Rainfall and Economic Growth in Africa”, *Journal of Empirical Economics*, *46* (1): 1-18.

Natural resources availability can definitely help underwrite growth and development. It did so for the U.S. in the 19th and 20th centuries. But Japan, Holland and Singapore are very resource poor nations that have had very successful growth and development, especially since 1950. And abundant natural resources do not guarantee growth. Nigeria and Venezuela are laden with oil wealth, yet people there are more poor there today than they were 50 years ago. Today some consider abundant natural resources a curse. Consider Russia—laden with oil and gas wealth at present. But Russia is not converting this natural wealth into human capital growth.

There are cultural effects on growth. To better understand this point, you might read, for example:

> Richard Tawney: Religion and the Rise of Capitalism, Piscataway, New Jersey: Transaction Publishers, (1998);
> Clifford Geertz: Peddlers and Princes: Social Development and Economic Change in Two Indonesian Villages, Chicago, Illinois: University of Chicago Press, (1968);
> ***OR***
> Jorge Ahumada: En Vez de la Miseria, Santiago de Chile: Editorial Del Pacifico S.A.,(1958).

But effects of culture on growth and development are not always what they may seem to be:

Note:
Examples: Japan, China, Malaysia
As a young graduate student the author was told that cultures based on Confucianism or Shinto could “never develop.”

> Twenty-five years ago at Harvard, Prime Minister of Singapore, Lee Kuan Yew said in my presence:"“Indonesia and Malaysia will always be poor, because ‘sarong cultures’ (where men wear sarongs) can never develop.”" Sitting there, hearing Lee Kuan Yew, I decided to say nothing about the sarongs I wore or my casual dress at home in Indonesia and Malaysia for many years. In fact economic growth was wildly successful in Malaysia in the past 40 years,and in some periods Indonesia (1972-1980, 2006-2012).

Trade and good policy can also help growth along. Chronically bad economic policy can by itself doom an economy to wrenching poverty.

Examples of corrosive bad policies:

- Ghana 1971-1985
- Nigeria 1965-2000
- Burma 1950- 2012
- Argentina 1948-1960, 1980-1990, 2008-2009, 2011-2013

What has mattered most throughout history and in the 20th and 21st centuries? A very good case can be made for Capital Formation and Technological Innovation.

And by capital formation we do not mean just physical capital formation — investments in equipment, roads, harbors, computers etc.

This kind of capital formation is indeed important. Consider the vast interstate highway system in the United States. Construction began under President Eisenhower in 1954. Of the billions upon billions invested on this road system since 1954, the rate of return has been 11%.

There are many other kinds of capital, deemed important by economists who study economic development.

- Physical capital
- Human capital

- Intangible capital (institutions, legal structure, governance mechanisms)
- Natural capital (forests, soils, water, energy, fisheries)

All of these are featured in this collection.

Consider Human Capital, which includes:

- Investments in primary and secondary education
- University education
- On-the-job training and formal training programs within business firms
- Learning “by doing”

Investments in Human Capital are critical for technological change and economic growth. Indeed, research by Bob Solow of MIT and his disciples suggests that, at least in the U.S., as much as 80% of growth has been due to investments in human capital and the associated technological change that goes with it.

Ten Major Lessons from Six Decades of Economic Development

By the end of this collection, it will be evident that several lessons emerge from the study of the past six decades of economic development. A summary preview of these lessons may provide the reader with a platform that will help knit together all of the important, and largely interdependent, factors influencing economic growth and development.

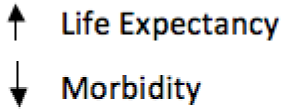
The ten most important of these lessons have to do with:

1) ***The Role of Human Capital in Economic Growth***

Human capital can be contrasted with physical capital. Physical capital consists of investments in plant and equipment, computers, transport and communications networks, roads, highway, aircraft etc. The role of physical capital in economic growth has long been recognized as critically important. But since about 1970, economists and other researchers have come to understand that investments in human capital are at least as important for economic growth as investment in physical capital.

Human capital is the name economists give to investments in education and health and other human attributes, that when combined with physical capital, harnesses human skills and ideas to make economic growth possible.

Such investments have a very high payoff: Worldwide, the annual rate of return on investment in public education has in recent years been on the order of 20%. And investments in the second most important component of human capital – public health – has had very high payoffs not only for economic growth but in enhancing the quality and length of life.



↑ Life Expectancy

↓ Morbidity

In countries rich and poor, education comprises the largest share of investment in human capital – all education, including primary, secondary and university education, and education within business firms such as on-the-job-training and learning by doing. So, the definition of human capital is very broad.

At this point you may be asking – what about the role of technology? Surely, you say, technology is vital for successful sustained growth. Of course it is. But in emerging nations, implementation of technological innovations – up until now, at least – has been totally dependent upon the size and quality of the human capital base. How is that? Like it or not, until the 21st Century, virtually all successful productivity-raising technologies were developed in the U.S., Europe and Japan. Unfortunately, most developing nations still trail the U.S. in technological usage by several decades. To harness technology for economic growth, developing countries have to be able to successfully transfer, absorb and adapt technologies developed abroad. There is only one proven way to do this: the technology-importing developing country must have already undertaken investment in human capital to nurture the requisite domestic labor force skills receptive to technological transfer. However, we will see that in 21st century, internet and mobile phones are technological innovations less dependent on a big human capital base.

The channels through which investment in human capital reduces poverty and increases empowerment of the poor are many and varied. This shines through clearly in the second lesson, as we will see.

For the past century, investments in human capital have been responsible for more poverty reduction, more economic equality and more economic growth than any other single factor. Simply put, absent super-abundant natural resource riches, sustained poverty reduction has not occurred where investment in human capital has been deficient.

Pause a minute and think about what it means to be either:

a. a poor person in a very poor nation like Bangladesh, Haiti or Liberia

   -or-

b. a poor person in a relatively better off nation such as Brazil, Indonesia or Colombia

In both circumstances, the poor have to deal every month with a "Quadruple Whammy":

1. Low Income
2. Irregular Income
3. Unpredictable Income
4. Unpredictable Expenditures (as for medicine, funerals etc.)

Results for poor inflows of money are chronically and severely mismatched over time. The first challenge in economic development is to do something about this mismatch. If you have no skills, either in Brazil or Bangladesh, you have no way of escaping this trap.

And if investment in human capital was critical before the 21st Century, it is even more important now and in the next few decades.

Why? Because the world economy and world trade are changing so fast.

Until the 21st century, individuals and nations could prosper by extracting value from the stock of knowledge already produced (in biology, information technology and innovations generally).

For the future, we may expect that economic growth - will depend heavily upon active and continuous participation in flows of new knowledge. And these flows will be in a state of perpetual renewal, in nanotech, biotech and infotech, to name a few examples.

The best, perhaps only, way to deal with this big shift - is investment in human capital.

2) ***The Role of Women in Development***

A growing economic role for women turns out to be important not just for economic growth, but for fertility decline, societal health and many other important quality of life issues. The female labor force participation rate is one indicator of the role of women in society. By way of reference, the labor force participation rate for women in the U.S. ages 15 and 65 in 2007 was 69.7%.[footnote] This figure fell to about 64% during the recession of 2008-2010. By 2014, the labor force participation rate for men was also about 64%. For all developing nations together the average labor force participation rate for males and females was 53% in 2007. However, for many of the fastest growing nations in the period 1990-2009, the labor force participation rates for women rose sharply. In some rapidly growing nations the increases in the women’s rate were especially striking: Brazil (30%), Chile (23%), Colombia (45%), Peru (54%) and Korea (14%). And while higher female participation rates are no guarantee of high growth, declining rates are typical in such slowly growing or stagnant nations as Albania, Ivory Coast, Haiti and Zimbabwe.

World Bank, *World Development Report 2013: JOBS*. Washington, DC: World Bank, Table 1, p.345.

In general, societies that fail to make use of the talents and skills of over half the population can expect to have low economic growth over long periods of time, unless they possess very large per capita endowment of oil and gas.

And, while critical for economic growth, a growing role for women in the economy is even more important for economic development and quality of life improvements. Consider fertility rates: the number of children a woman will bear over her lifetime. We will see in Chapter 2 that in the past 30 years, there has been a very sharp decline in fertility rates around the world, especially in nations outside of the Middle East. Half of humanity is now having only enough children to replace itself (2.1% fertility rate or less). In 1970, only 24 nations had a rate of 2.1% or less. Now there are 70 nations. As we will see it turns out that rising female participation in the labor force explains much of the decline in fertility. In turn, rising female participation in the labor force has been very dependent upon increased investment in Human Capital in primary and secondary education of women.

3) ***The Role of Institutions in Economic Development***[footnote]

See Acemoglu, D., S. Johnson and J. Robinson, "The Rise of Europe", *The American Economic Review,* Vol. 95(3): 546-579.

Until very recently, the role of institutions in fostering or hindering economic growth was poorly understood. Four institutions especially important for economic growth and development are:

- Those pertaining to property rights
- Those pertaining to contracts and trust
- Those pertaining to governance
- Those pertaining to conflict resolution

Social Scientists argue about the question – are well-functioning institutions a cause of economic growth, or are they a result? There are no settled answers to that question. But clearly, some institutions are corrosive to economic growth and development. Slavery, that "peculiar institution," is one example. Inheritance laws in some nations another. For example, wives in some Middle East nation can inherit at most only half of an estate.

Institutions have been of prime importance in facilitating or impeding economic progress for at least two and a half millennia, beginning with early Rome. Economic historians now understand the importance of both formal institutions, such as those pertaining to property rights and informal institutions. The latter include networks among traders, traditional arrangements for social conflict resolution. Such institutions played a major role in establishing Roman prosperity. As a result, overall standards of living for Roman citizens in 200 C.E. were just about as high as that of 17th and 18th Century Europe. Rome had better paved roads, better sewage disposal and better water supply than did the malodorous capitals of Western Europe in 1750, 1500 years later.

The institution of property rights turns out to be especially important. Everywhere, nations have found that a lack of well-defined property rights, or frequently in the past in socialist nations, government ownership of all property rights, is rarely consistent with efforts to make sustained inroads against poverty. And growth favoring property rights do not always have to be vested in individuals. They can be vested in groups, but they must be well defined.

Changes in property rights contributed to China's very rapid economic growth of near 10 percent since 1980[footnote]. From 1949 to about 1980, Communist ideology prohibited private land ownership. Farmland was exclusively owned by the village collective. Then in 1984, farmers in mass regions were allowed to lease or sell their right to farm. Some rights to agricultural land were returned from the collective to the household level. Agricultural production increased sharply within a few years. In many urban areas over the past decade, ownership of housing has passed from government to private households. As a result the new owners are increasingly insisting on clean environments, and less pollution. The Government in China in 2014 was considering new revision to property rights to allow more private ownership of urban, not rural land.
In China property rights in rural areas were still in some flux by 2014.

Lack of well-defined property rights to agricultural land in Indonesia hobbled growth in agricultural productivity for decades. As we shall see in a later Module, in Ghana, the transfer of property rights to that nation's formerly rich rain forests from traditional tribal owners to the central government in the 1960’s played a significant role in the later devastation of that nation’s tropical forest endowments. The vesting of the ownership of forested lands in the central government has also been a significant factor underlying rapid deforestation in Ivory Coast and Indonesia, while ambiguous property rights led to similar results in the Brazilian Amazon until very recently.

This book discusses property rights and the tragedy of the commons at some length. Increasingly, we observe examples of poorly defined property rights adversely affecting sustainable use of such natural endowments of water and fisheries.

4) ***The Importance of Sensible and Sustainable Use of Natural Resource Endowments***

Nature’s endowments can be utilized in ways supportive of growth and poverty reduction for the benefit of both present and future generations. But when these endowments are abused, we find both environmental degradation and economic decline. Throughout history, environmental catastrophes are always economic catastrophes, and some economic catastrophes have been environmental catastrophes.

In this book, time dictates that we focus on only four types of natural endowments:

- Water
- Energy
- Tropical Forests
- Fisheries, especially ocean fisheries

One type of resource is not fully discussed: Hard Minerals. Why? Because the nature of technological change in mineral mining and processing is not nearly as interesting. Also, the author has two books[footnote] on minerals that students may consult.
Malcolm Gillis, et al. (1978), *Taxation and Mining: Non-Fuel Minerals in Bolivia and Other Countries*, Cambridge, MA: Ballinger Publishing Co; Malcolm Gillis, et al. (1980), *Tax and Investment Policies for Hard*

Minerals: Public and Multinational Enterprises in Indonesia, Cambridge, MA: Ballinger Publishing Co.

Sensible use of natural resource endowments fosters sustainable growth and development. What does that mean? Sustainable development requires sensible development policies and institutions affecting natural resources. Sensible policies and institutions are those that maximize the long-term, net benefits to society, taking into account any costs of environmental degradation and depletion. Net benefits are benefits after deduction of costs. These benefits include not just income gains, but also healthier living conditions for present and future generations. Costs include pollution and degradation of the environment, as well as ordinary costs of exploration and extraction.

Experience over the past half century suggests that sustainable use of fresh water, energy, tropical forests and fisheries requires that at least two important conditions be met:

1. That the resources not be underpriced,
2. That systems of property rights are consistent with efforts to foster conservation and sustainability.

As in California and Florida, many emerging nations now confront a critical shortage of water, not only for irrigation, but also for drinking. Eighty percent of nations that are water-poor are developing countries. The water crisis has become acute for Mexico City and Lima. For Peru climate change has played a role, particularly with melting of mountain glaciers owing to warming. Historically the most important cause of looming shortages of potable water has been gross under pricing of fresh water resources used by agriculture and industry. Around the world seventy-five percent of fresh water is used for irrigation in agriculture, while fifteen to twenty percent is used for industry. Only five to ten percent is used for households.[footnote] Deep subsidies for irrigation water in particular have led to egregious waste of water worldwide. Continued under pricing of this precious resource in the poorest nations will of course have large implication for health and nutrition.

World Water Assessment Programme. Retrieved from http://www.unwater.org/statistics_use.html.

When water or energy is priced like dirt, each will be treated like dirt. Energy resources have also been deeply underpriced in many developing nations. (Iran, Venezuela, India, and Pakistan). In Venezuela the dollar cost of a gallon of gasoline in 2014 was $1.00 per gallon. Adverse consequences include energy waste, and serious, needless air and water pollution.

As we will see in Module 13, pricing and property rights have both played major roles in rapid rates of tropical deforestation since 1960. The tropical forest covered 12% of the earth's surface in 1960. Now it covers less than 5%.

And, surprising to most, deforestation is responsible for fully 20% of global carbon emissions per year.

In virtually all developing nations and most of Europe, governments own the property rights to all oil and minerals; not individuals. Governments own property rights to more than 95% of tropical forest land. But governments have so underpriced tropical wood that harvests have long been excessive and needlessly wasteful, especially in Brazil, Indonesia and West Africa. Curbing the destruction of tropical forests will require that two measures be implemented:

1. Increase the cost of harvesting tropical wood, to reduce waste. This can be done through higher timber royalties.
2. Rearrange property rights to tropical forests, as is being done in Colombia, Peru and Brazil.

Government ownership of such rights leads to the familiar tragedy of the commons: when something is owned by everyone, it is owned by no one. That being the case, there is little incentive to maintain it or improve it. In Colombia, Peru and finally, now Brazil, central governments have begun vesting property rights to the forest to local farmers and groups of farmers, to encourage them to improve that land instead of clear-cutting it and moving on.

Fisheries are important resources for all countries, but especially poorer nations because fish is a more critical components of diets in poor nations. But with some exceptions (halibut, mackerel) fishery stocks are in serious decline almost everywhere, because of over-fishing: over 75% of all marine fish species are on the brink of falling below sustainable levels. The main, but not the only, cause of overfishing is another illustration of the tragedy of the commons. Where fish stocks are treated as common property, no one has incentives for sustainable fishing or fishing patterns that would provide fish as a food for future generations and biodiversity for the oceans. We will discuss some approaches to sustainable fisheries, particularly given the threat to fisheries posed by global warming and acid-function of the oceans.

5) *The Role of Fiscal Policy, Tax Rate Regimes, Government Investment and Capital Mobility*

The past half century yields several striking lessons concerning the role of fiscal policy in financing growth generating public savings, and affecting income distribution, in a world where capital is internationally mobile.

Experience in both rich and poor nations shows very clearly that the best and highest purpose of a tax system is to raise significant amounts of revenue at the lowest economic and administrative costs, in order to finance vital public investments, both in human capital and in physical infrastructure such as school buildings, transport and communication facilities.

Another closely related lesson from the past half-century concerns the tax policy implications of the international mobility of capital. Capital is now very mobile internationally. In the first decades after World War II, the design of tax policies in both rich and poor countries was based on the assumption that capital would not migrate in response to policies such as very high tax rates that reduce its return. Total world financial assets exceeded $150 trillion by 2007 before the meltdown of 2007-2010. By 2012, global financial assets grew to $225 trillion. This capital is sufficiently mobile everywhere so that attempts to apply high corporate income or other capital taxes have had very disappointing results: capital tends to flee when the taxes drive down its net-of-tax return much below what it can earn elsewhere.

6) *The Role of Foreign Trade Regimes, Flexible Exchange Rates and Real Exchange Rates*

The Clinton Administration (1993-2001) was convinced that International Trade was the surest, and usually the shortest path to improved living standards. This is why President Clinton stressed the need for the creation of NAFTA (The North American Free Trade Area) in 1996. While NAFTA has had relatively small benefit for U.S. and Canada, big benefits for Mexico. U.S. Trade with Mexico increased by 506% from 1993 to 2012, whereas U.S. trade with the rest of the world grew by only 279% over the same period. Countries that have consistently relied on strongly protectionist policies have experienced relatively limited economic growth (North Korea, Tanzania before 1998, Burma, India before 1932, and China before 1980).

Trade is greatly affected by a key macro price: the exchange rate. The nominal exchange rate is the one quoted daily in the press – say 1 Euro = $1.33 dollars. The real exchange rate, rather than the nominal rate, turns out to be one of the most consequential of all magnitudes in economic development. The real exchange rate reflects not only the nominal exchange rate, but changes in relative inflation rates across nations as well. The real rate of exchange exerts strong effects on import or export of traded goods. A realistic exchange rate regime is one in which a country's nominal exchange rate adjusts to differential movements in the rate of domestic inflation so as to maintain appropriate real exchange rates. World experience has shown that policies using flexible exchange rates are far more successful in achieving this objective than are the type of fixed-exchange rate so commonly applied from 1945-1990. We will see in China that with flexible exchange rates, movements in real exchange rates are small and gradual, affected mainly by changes in domestic prosperity. Conversely, under a fixed exchange rate regime, economic damages from inappropriate macroeconomic policies can be concealed for a time, but corrections follow, and always involve large devaluations usually with disastrous effects. However, that is not to say that a flexible exchange rate system is free of problems. For example, sudden, unforeseen capital flight can occur.

7) ***The Importance of Price Stability***

Experience over centuries furnishes ample evidence that sustained inflation at rates much above 2 percent per year is, everywhere and always, a result of monetary expansion. Most commonly, inflation in poor countries has been the consequence of monetary expansion used to finance domestic budget deficits often exceeding 10-15% of GDP. Some nations especially in Latin America and Africa have experienced the trauma of hyperinflation (inflation >100% year) which sometimes reaches 2,000% per year. Governments often attempt to suppress inflationary pressures by resorting to price controls and by clinging to a fixed exchange rate. The usual result is serious resource misallocation, economic misery and a badly misaligned exchange rate that cannot be sustained. One of the important questions we will address in Econ 460: How can it be that budget deficits of 6-8% GDP are not very inflationary in the U.S. but can be very inflationary in poor nations?

Countries that chronically suffer from domestic inflation in excess of world inflation strongly tend to have lower economic growth. Chronic inflation has insidious effects: it reduces investment and warps it toward shorter time horizons. It undermines domestic tax systems and weakens domestic financial institutions. And finally, inflation really worsens income distribution worldwide; the brunt of the burden of inflation has long been borne by the weakest, poorest groups in society.

8) ***The Role of Financial Institutions, Financial Development and the Real Interest Rate***

For three decades after World War II, governments on all continents (to one degree or another), sought to subsidize loans to favored groups or economic sectors. How? By holding nominal interest rates not only below market rates, but also below inflation rates. This results in negative real interest rates, which in turn results in what is called "shallow finance". Shallow finance reduces the overall availability of finance, and at the same time misdirects financial flows by under-pricing of capital. It has corrosive effects upon growth and income distribution. Shallow finance is also bad for employment in labor-surplus nations (most lesser developed countries, or LDCs) because it produces artificial incentives for capital-intensive techniques of production. Therefore shallow finance is also bad for income inequality.

There is an alternative that has been used successfully by several countries: a strategy of deep finance. Countries employing techniques of deep finance, especially the maintenance of positive real interest rates (interest rates in excess of inflation) have reaped large benefits. Deep finance is an essential component of “bottom-up development.” It fosters sustained, healthy growth in the real size of the organized financial system with consequent improvements in growth prospects. It also helps improve income distribution. How can it do that? Deep finance allows greater access to credit and economic empowerment for small businesses and for marginalized groups in society. The much vaunted, and generally successful micro finance movement in India, Indonesia, Peru and Mexico, among other nations, is but one of the outgrowths of deep finance strategies. Readers of this collection will come to understand something of the importance of key MACRO prices in economic growth. Like the real exchange rate, the real interest rate, the wage rate, as well as basic prices of agricultural products.

We will also see that totally new forms of financial institutions have arisen. An example in developed nations is the giant firm BlackRock, the largest investor in the world ($4 trillion in directly controlled assets and $11 trillion under management). But some of these new forms of financial institutions first emerged in emerging nations, and they are not at all large. The most prominent of these are institutions for micro-finance, which focus strongly upon lending to the poor. Microfinance originated in Bangladesh in the late 60s and spread to India, much of tropical Africa, Latin America and, by 2005, even the United States.

9) ***The Importance of Fluid Markets in Agriculture, Industry and Services***

Markets heavily fettered by regulation and price controls reduce prospects for economic growth. The need is for fluidity in markets. Nevertheless, since the reign of the Roman Emperor Diocletian nearly 2,000 years ago, governments have imposed price controls in the belief that some important economic, social or political objective might thereby be served (i.e. control of inflation, protection of the poor, etc.). In Diocletian’s time, the stated punishment for evasion of price controls by merchants was execution. Moderate governments have not resorted to this sanction (with some exception in the Soviet Union in the 1930s and China in the 1950s).

In 2014, the most notable examples of severe price control regimes were Venezuela and Argentina. Venezuela imposed very stifling price controls on food and other products with zero impact on inflation, which reached 40% in 2014. The resulting drastic shrinkage of the agricultural sector yielded bad results for Venezuelan farmers (and consumers) but very good results for US. exporters of food grains, especially rice.

A definitive lesson emerging from more than 2000 years of history is that, except in wartime, price controls not only ultimately fail to secure the objectives sought, but have highly corrosive effects throughout an economy.

Price controls on agricultural products have had especially pernicious results in poor countries, in reducing rural incomes and undermining urban nutrition. Especially during the 60s, 70s and 80s, tropical African nations resorted frequently to use of price controls for agricultural products, in the mistaken belief that the interests of poor consumers would be served. In the disastrous Indian famines before 1950, people starved NOT because of a shortage of food, but by restrictions on the rice market (price controls). [footnote]

See Amartya Sen (1981), *Poverty and Famines: An Essay on Entitlement and Deprivation*, Oxford, UK: Oxford Clarendon Press.

Fluidity in markets essentially requires a degree of shortage economic freedom in markets. This in turn relates to Module 9 (Institutions). We now have ranking of economic freedom. In the 2010 International Index of economic freedom, the freest 20% of economies (31 nations from Hong Kong to Spain) have doubled the per capita income compared to those in the second quintile of economic freedom. The U.S. was ranked #10 in 2012 and fell to #12 in 2013. A more telling comparison: the 20% freest economies have per capita income five times that of the lowest quintile in per capita income.

10) ***The Role of Foreign Investment and Foreign Aid in Fostering Economic Development***

Foreign aid comes in two basic forms: official (government) and unofficial (private). Official foreign aid includes economic and military aid. It includes also aid for recovery from disasters, whether due to war, storms or earthquakes. Foreign aid is clearly appropriate and is usually effective in disaster recovery efforts, as in Europe under the Marshall Plan in the 1940s or as in relief for the Asia tsunami in December 2004. Even in 2014, Haiti is largely dependent on foreign aid, a decade after disastrous earthquakes there.

The principal stated purpose of other types of foreign aid has been to increase rates of economic growth in recipient nations. Judged by this standard, official foreign aid has been at best only mildly successful; in a very small number of cases and at worst a failure generally. The record over the past half-century is fairly clear: the one quarter of poor nations that have been most heavily dependent on foreign aid have also been those that have grown most slowly. The one quarter of nations that have been least dependent on foreign aid have, by far, superior records of economic growth. Indeed, there is evidence that aid inflows have systematic adverse effects on the growth of labor intensive and export sectors in recipient nations. Other than for disaster recovery aid, foreign aid has generally supported "top-down" development, rather than the type of bottom-up development evident in such successful approaches as microfinance.

Reliance on foreign aid to support the top-down approach has meant that a sizable group of nations, especially in tropical Africa, has developed long-term dependence upon aid to **(a)** feed their populations and **(b)** deliver basic government services and, finally, **(c)** support corrupt bureaucracies. Given the poor governance of the nations that have historically been most dependent on aid, it should not be surprising that the most widely accepted worldwide indices of government corruption have such aid-dependent nations at or near the very bottom of their lists.

The overall conclusion: official. foreign economic aid is broken. But it should be mended, not ended. New, innovative bottom-up foreign aid is beginning to yield good results, as we will see in Module 7.

These, then, are the basic lessons the author considers the most significant from the past half-century. We should not be at all surprised to learn that, going forward another fifty years, these lessons will remain germane, even while new ones will surely emerge.

HISTORIC PERSPECTIVES: ECONOMIC AND POPULATION GROWTH

All too often, economists and policymakers ignore, or overlook, important lessons of history, both recent and distant, to the detriment of economic growth.

An Illustration from Recent History

Less than 20 years ago, amidst great drum rolls and high expectations the common currency called the Euro was launched. The Euro is a child of former French President Valery Giscard d'Estaing and former German Prime Minister Helmut Schmidt. Not all 27 members of the European Union (EU) have adopted the Euro. Britain and Denmark are prominent among EU nations who kept their own currency.

Why did most EU nations adopt the Euro?
They believed a common currency would facilitate more intra-Eurozone trade and lead to both lower costs and lower growth.

Why did Britain and Denmark stay out of the Euro?
They did not want to lose control of Macro forces in their nations.

Why does the Euro face an uncertain future?
Because, for members of the Euro, the Euro is a form of fixed exchange rates.

As we will see in Chapter___, recent economic history provides ample evidence that fixed exchange rate regimes cannot be made to work in a globalized world economy. The empirical evidence over the past forty years makes this clear.

Why then did so many economists argue in favor of the Euro from 1990 to 2010? Because economists in the U.S., Europe and elsewhere deeply wanted the Euro to work. Economists as well as politicians convinced themselves that a fixed exchange rate would work, in spite of all the contrary evidence available. Why?

Not for the first time in history wishful thinking interfered with good economic analysis.

In the years leading up to adoption of the Euro then a widespread belief that a common currency would lead to greater economic and political integration of Europe.

One reason why economists generally failed to anticipate the difficulties encountered by the Euro was that they had tunnel vision, as they focused primarily on the role of the exchange rate in isolation, rather than as one important part of complex economies of the 21st century.

Also, why have almost all economists failed to anticipate other important economic disasters, including disasters in the 21st Century such as the dot.com collapse of 2001-2002, when irrational exuberance led to vastly inflated values in the stock market for so-called dot.com companies?

And why did they fail to anticipate the economic meltdown in the U.S. and Europe beginning in 2008 persisting until 2010, with only weak recovery thereafter?

Why were these surprises?
Because too many economists, even good ones competent in their own fields often view the world economy through NARROW-ANGLE lens. What is needed is a world view, a Weltanschauung, informed by using a wide-angle lens on the world economy.

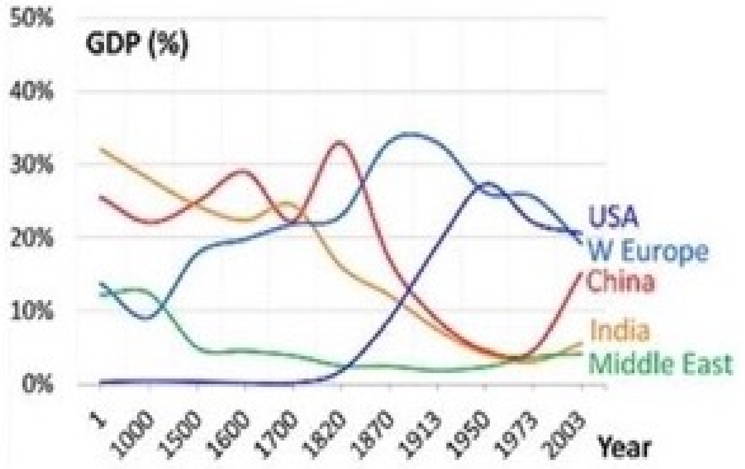
We will see that, in the study of economic development, we have a special need for using a “wide angle lens,” especially since what happens in one part of the world economy has major and often immediate impacts on other, apparently unrelated parts of the economy.

Perspectives from Older History

Much of the discussion pertaining to early historical economic magnitudes is based on the voluminous work of Angus Maddison (1926-2010). Professor Maddison, over his long career, published dozens of articles and ten major books on measuring economic magnitudes from 1 to 2010 C.E. Two of his most recent books on these topics were:

1. Contours of the World Economy, 1-2030 AD; Essays in Macroeconomic History, U.K: Oxford University Press, September 2007.
2. Chinese Economic Performance in the Long Run, 960-2030, Paris: OECD, October 2007.

GLOBAL CONTRIBUTION TO THE WORLD'S
GDP FROM LARGE ECONOMIES
YEAR 1 TO 2003 AD



Source: Angus Maddison, Contours of the World Economy, 1-2003 AD, (Oxford University Press, 2007)

Consider these figures in Maddison's work: by 1820, China's population reached 381 million, tripling between the 17th and 18th centuries. With such rapid population growth GDP per capita in China grew very little, not only from 1700 to 1820, but until 1982 (See Figure 2-2).

Tiny Britain in 1700 had 8.6 million people producing only 3% of world output. But Britain dominated world trade by 1900, by which time the City of London's population had reached 6 million, and by 1900, Britain ruled one quarter of the world's people.

Now consider, what happened AFTER 1820, the past two centuries of human history.

From 1800-1990, there was a "great divergence", between economic growth in China on the one hand and Europe and North America on the other.[footnote]
Brandt, Loren, Debin Ma & Thomas G. Rawski. 2014. "From Divergence to Convergence: Reevaluating the History behind China's Economic Boom." *Journal of Economic Literature*, 52(1): 45-123.

But after 1990, there was a "Great Convergence."[footnote] Convergence was widely expected in 1950, but did not begin until 1990. Meaning the period 1790-1990 was a period of acceleration of technological change in Europe and U.S., and to an extent Japan after 1880). This led to divergence, not convergence.
Michael Spence (2012), *The Next Convergence: The Future of Growth in a Multispeed World*. New York, NY: Picador Press.

The result was that by 1990, per capita income in the West reached very large multiples of India, China and Brazil (multiples of 20, 25).

The great divergence lasted for 2 centuries. Recently another historic change has been shaking up the world order. A great convergence has been underway. Convergence in living standards, health, longevity, technology, and to some, but by no means all, in political freedom.

Why has there been an economic convergence? Because many countries that were poor before 1990 learned how to speedily adopt and adapt technology and know-how, and abandoned policies that inhibit or slow growth.

Of course, some nations have experienced little growth since 1950. In 1950 Japan's per capita GDP was about 1/3 that of Argentina. By 2011 the ratio was reversed. Argentina's per capita GDP is now 1/3 that of Japan, for reasons discussed in several chapters of this book. A major question in economics is will the great convergence prove to be lasting or merely temporary? We will touch upon the question at several intervals in this book.

It may be useful to examine some relative magnitudes for a moment, involving industrial nations and emerging nations.[footnote]
Source: CIA World Factbook

First: Consider that emerging economies (developing nations) in 2013 had 85% of the worlds’ population.

Some Regional Populations	
EU	504 million people
US	305 million people
Russia	142 million people
China	1.35 billion people
India	1.2 billion people
Market size (Approximate in 2013 US Dollars):	
EU	16 trillion
US	16 trillion
Russia	1 trillion
China	12 trillion

India	5 trillion
Total World Exports in 2012	18.3 trillion - Larger than the total GDP of the EU[footnote] Source: CIA World Factbook

Further Perspective - The Rise of the Chinese Economy

Any economist in 21st Century needs to understand the rise of China. When the author began teaching Economic Development 45 years ago he had little to say about China.

Why?

Because it was such a closed society then. Economists knew little about Chinese industry, agriculture or trade. Now that many flows of information on China have opened it is imperative that we develop an understanding of both ancient and modern China.

Consider some pertinent aspects of Chinese history:

In China during the Ming Dynasty (1402-1626) Chinese per capita GDP was probably about equal to that of Britain. By the early 1400's, Chinese technology was, most probably superior to that of Europe. This was surely the case in maritime technology: large Chinese ships had sailed all the way to the Cape of Good Hope in Southern Africa. Well before the voyages of Columbus and Magellan China ruled the seas. Chinese Admiral Zheng He took a huge, well-armed fleet of large ships to East Africa, bearing gifts from the emperor. Admiral Zheng died in 1433. For reasons still unclear today, the Mandarin ruling class then began to view technological progress as a threat to their status, and they made the grip of feudalism even tighter. The Mandarins made building a ship with more than 2 masts a crime punishable by – death. All of Admiral Zheng's navigational data was destroyed. In ensuing decades, all the great Chinese ships were recalled and then burned while other technologies were suppressed. China turned sharply inward. Per capita income growth stagnated for the remainder of the Ming Era (1402-1626).[footnote]

David Li, Hanhui Guan & Stephen Broadberry (2014). “China, Europe and the Great Divergence: A Study in Historical National Accounting, 980-1850”.

By 1626, the end of the Ming Era and the dawn of the Qing Empire (1644) per capita income was about half that of preindustrial Britain.

At that time, agriculture was 90% of Chinese GDP. From 1500-1600 the national savings rate was, as best as we can tell, negative, i.e. There was virtually no accumulation of capital during that period. This makes growth impossible, as we shall see.

Nearly four more centuries of economic stagnation followed, even as Britain and then, Western Europe and North America entered a period of unprecedented technological and institutional innovation that led to the Industrial Revolution in the early 1800s.

Comparisons between the U.S. and the Chinese experience are striking, as noted in [link].

1820	2X
1870	5X
1913	10X
1968	33X
1980	26X
2007	8X
2011	7X

U.S. Per Capita GDP as a Multiple of Chinese GDP 1820-2007Source: Niall Fergs forthcoming, and World Bank, World Development Report, 2011, Washington, D.C., 2011.

The period 1910-1970 was especially catastrophic for the Chinese economy: revolution and civil war early on, followed in the 1930s by a brutal Japanese occupation, revolution again in the 1950s, famine, purges, and rampaging “red guards” under Mao Tse-tung.

In sum, the Chinese economic experience from 1400-1980 may have been the most wretched in world history, considering that China was almost on an equal footing with Britain in 1400. But, less than 25 years after the 1982 reforms introduced by Premier Deng Xiaoping, there was a complete reversal of fortune: Chinese GDP grew 10-fold in a quarter century. Note that the U.K. required 70 years after 1830 just to grow 4-fold. Note again, by 2011 U.S. per capita GNP was only 7 times that of China.

In the early 1980s, Deng Xiaoping, then almost 80, wanted China to get on with building the economy and avoid ideological battles. He wanted the economy to save the communist party. It has, at least through 2014.

Why was China’s economic performance in the nearly five centuries after 1400 so dreadful? And why has economic performance been so spectacular since the early 80s? And can China’s spectacular growth continue after 2014?

To approach an answer to these questions, consider key features of the economy in the period: 1400-1980

1. Suppression of technology
2. Severe lack of savings and physical capital accumulation
3. Absence of competition, domestically or from abroad (isolation)
4. Lack of investment in Human Capital (education, public health)
5. Perverse institutions (feudalism 1400 to 1947, then doctrinaire Communism followed from 1950-1982[footnote]
   An exhaustive account of the role of perverse institutions impeding China’s growth after 1800 may be found in Loren Brandt, Debin Ma &

Thomas G. Rawski (2014), "From Divergence to Convergence: The History Behind China's Economic Boom", *Journal of Economic Literature*, 52(1): 45-123.

What accounts for the sharp turnaround in China's economic fortunes after 1982?

One could argue that much of the explosion in Chinese economic growth since then can be explained by a near reversal of these factors.

1. New technologies were eagerly embraced, especially imported technologies
2. Very high saving rates: 40% of GDP in the early 21st century leading to rapid capital accumulation
3. Some opening to competition from abroad, through foreign investment
4. Expanded investment in human capital, especially since 1970 - especially notable is the very high literacy rate. Indeed, the youth literacy rate is 99% as compared to only 81% in India.

It is important to keep China's very recent rapid growth in perspective. Real rates of economic growth (9-10% per year) have indeed been very high, but from a very low base (one twenty-sixth of the U.S. base in 1968). Also consider the "catch-up" factor: centuries of stagnation before 1968 meant that there was a lot of growth required just to begin to catch up to the industrial West.

In any case, economists and historians will be arguing for decades to come over the relative importance of these and other factors in explaining Chinese economic growth since 1980.

However, some signs are beginning to appear of slowing prospects for Chinese growth, including environmental pollution and the burden of a very large and inefficient state-owned enterprise sector.

Postscript on Chinese Economic History

Karl Marx, in Das Kapital, viewed capitalism as an essential phase in social progress. But capitalism was to him only a phase in a gradual societal transformation to socialism and thence to full communism.

History so far has not worked out this way, certainly not in Russia or China. But the Chinese experience over 500 years does suggest perhaps socialism (or communism) may in some cases be an essential phase in the transition of societies from feudalism to state capitalism (heavy reliance on state-owned enterprises, government credit).

Has the final stage in the evolution of the Chinese economy now arrived? Will the Chinese economy be able to sustain relatively rapid rates of economic growth over time?

Perhaps the best way to approach an answer to this question is to bear in mind a quote from the most famous and perhaps most accomplished civil servant in modern Chinese history: Chou-En Lai. He was the first Prime Minister of China (1949-1976) and a leader of the Chinese communist party, beginning with the “Long March” to Yunnan province, led by Mao Tse-tung 1934-36.

When asked by the French Ambassador his opinion of the French Revolution in the late 18th century, Chou was reported to have replied:

"It is too soon to tell."

Growth Perspectives from the Russian and East European Experience

Russia is a very large country, larger than the U.S. in land area by far. But the Russian economy in 2012 (measured by GDP) was only about twice the size of the state of New York, and was about the size of the Australian economy. Russian GDP in 2013 was $2.55 trillion. That of New York was $1.23 billion.

Consider the nation of Belorussia as compared to the state of Alaska. Both Alaska and Belarus were formerly a part of Russia. Today, in thinly populated Alaska, GDP is roughly the size of populous Belarus GDP[footnote] after 15 years of Socialism in post-Soviet Belarus.

Belarus GDP: US$ 54.71 billion (2010) The World Bank.

Other Perspectives from Economic History

Economists in particular, and Americans in general do not listen clearly enough to the rhymes of history. Often in this book we will find it helpful to utilize historical perspectives as we try to understand modern economic development.

Consider Income Patterns:

U.S. per capita income in 2013 was about $51,000, while per capita income in 2013 for the poorest nations was as follows:[footnote]:

Congo Kinshasa	$394
Zimbabwe	$589
Ethiopia	$203
Burundi	$640
North Korea	$800

Those are only "snapshot" figures.
For all such information see World Bank (IBRD) *World Development Indicators 2013*. (World Bank, Washington, DC, 2013)

But what about long-term income growth?

All modern studies of long-term growth must recognize the contributions of the economist Angus Maddison. Until a few years ago, economists knew little about ancient and medieval economic data. Maddison, who died in 2010, pioneered and inspired the meticulous kind of research that allows us some plausible estimates of per capita GDP in ancient Rome and medieval Europe. Angus was deeply fond of numbers, and was very careful how he used the results of his stone-by-stone research. Thanks to the lifelong work of Professor Maddison and several other scholars, we now have a much better understanding of the evolution of average world per capita income over time.

Basically, for thousands of years the standard of living worldwide was roughly constant, and it did not differ greatly across countries. That is to say throughout most human history life was brutish, nasty and short. Per capita income (in today's money) globally was about $445 in the year 100 C.E., or more than Congo Kinshasa in 2013.[footnote] Nearly a thousand years later (1,000 C.E.) living standards had deteriorated, and per capita income had globally declined by about 2%.
According to one economist historian, the Rome of 100 C.E. was a better place to live than the capitals of Europe in 1800; Rome had better paved streets, sewage disposal, water supply and fire protection in 1800 Europe. Joel Mokyr (1992), *The Lever of Riches: Technological Creativity and Economic Progress*, New York, N.Y: Oxford University Press.

These reasons were manifold: wars, disease (Black Death), pestilence, lack of sewage treatment, lack of technological progress, lack of Human Capital formation along with other reasons noted earlier. Also, in almost all nations after the fall of Rome until the 1800s, in those periods wherein per capita income temporarily improved, something happened to cancel the gain, such as rapid population growth.

The Malthusian Mechanism (Malthusian Trap) is typically used to explain this pattern. It was named after Reverend Thomas R. Malthus (1766-1834) who focused also on economic issues. Malthus was profoundly pessimistic about prospects for income growth per capita, anywhere, including Britain. Experience up until recently seemed to bear him out.

From 500 C.E. to 1200, population growth moved almost apace with economic growth. With any rise in economic growth, fertility rose, as families sought more children. This led to increased population and a decline in Income Per Capita. The result was widespread starvation, then decline in population. Income Per Capita would then rise and the cycle would begin again.

This began to change somewhat as Western Europe emerged from the Dark Ages. Increased exposure to some types of education and moderate improvements in public health led to beginnings of technological change and growing international trade, and some income growth.

By 1820, just as the Industrial Revolution was hitting its stride, average annual per capita income had risen to $667. In 2013 dollars this was a 50% increase over that of 1000 C.E.). But, this reflected a truly negligible annual growth rate of less than 1/10 of 1% per year).

By 1900, the early fruits of the Industrial Revolution plus the beginnings of a vast expansion in world trade led to the beginnings of modern economic growth, as well as large increases in population growth.

Digression on Population Growth

Early humans living about 1 million years ago (according to geneticists who study ancient DNA) were extremely close to extinction.

Such evidence as is available suggests that one million years ago, the population of various early human species was about 55,000 individuals (including Homo erectus, Homo sapiens and Homo ergaster). In the U.S. we place species that fall below 50,000 in number on a warning list, before they reach the “endangered list”.

As best we can tell, there was only negligible growth in the number of humans for the next 800,000 years. Things began to change in the millennium before 1 B.C.E. Human population reached 6 million in 8000 B.C. By 1100 C.E., the world human population doubled. This was due mainly to slow but steady improvements in agriculture, drinking water, and sanitation as well as technological innovation in the Roman Empire (using technology largely taken from Egypt).

From 1100 to 1700, the world’s population doubled again, to 600 million (20 million in North America, overwhelmingly Native Americans).

Really explosive population growth began in the 150 years after 1700: world population doubled from 600 million to 1.2 billion by 1850.

Then world population doubled again from 1850-1950 (100 years) and doubled again in the next 50 years.

200 B.C. – 1100 A.D.	1300 years
1100-1700	600 years
1700-1850	150 years
1850-1950	100 years
1950-2000	50 years

Intervals for Doubling of Population

Notice in [link] that the interval for doubling of population fell from 1300 years to only 50 years by the year 2000.

This record was the basis for some very gloomy predictions about population in the last part of the 20th Century, as we shall see.

Population Today
What was world population in 2013?
4 billion? 6 billion? 8 billion? 10 Billion?
Answer: 7 billion

What is the total population of low and middle income nations?
2 billion? 4 billion?
Answer: 5.6 billion

What was the average annual population growth for the world from 1990-2007?
1.0%? 1.3%? 1.8%? 2.0%?
Answer: 1.3%

And for low and middle income nations?
1.5%? 2.0%? 2.5%?
Answer: 1.5%

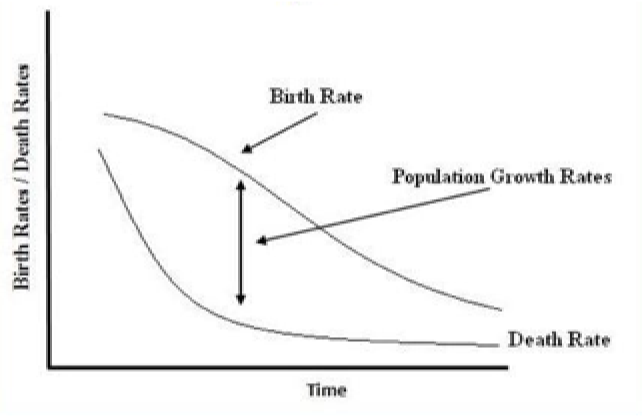
In the 1960s and the 1970s and part of the 1980s, economists, demographers, U.N. agencies, etc. “reasoned” that the “ever-contracting” period of population doubling was inevitable.

In the seventies and eighties demographic experts at Stanford and in the U.N. were predicting a runaway growth in world population, with most of the growth coming in developing countries.

A review of the eighties literature on economic development and population is revealing. No phrase was more politically correct in the seventies and eighties and even in early nineties then the dreaded words “world population explosion.”

But a strange thing happened on the way to the explosion. This has become one of the central lessons of development economics today.

The world is now in midst of sharp demographic transition: widespread decline in birthrates and death rates. We can represent the demographic transition as in [link].



Another most welcome feature of the demographic transition since 1970 has been very sharp gains in the life expectancy in emerging nations.

Latin America	22.1
Africa	17.0
Asia	26!
Europe	10
North America	10
WORLD	20

Since 1955 - Gaints in Life Expectancy (Years)

But even more striking was what happened to fertility. As late as the 1980s seers such as Paul Erlich of Stanford were issuing shrill warnings about the effects of high birthrates. Erlich wrote a book called The Population Bomb[footnote]. But in the past three decades, population growth has been leveling all over most of the world, often sharply. About one-third of

countries now have birthrates below the 2.1 children per woman that is the population replacement level. The "population explosion" has "imploded."
Published by the Sierra Club/Ballantine Books in 1968.

Instead, there is now a "birth-death" in many nations, including Japan, South Korea, Italy, Spain, Germany and Russia (fertility below 2.1). China, should it continue its one child per family policy much longer, will soon follow that pattern.

But even more striking, fertility rates[footnote] (the number of children born to each woman of child-bearing age) are declining all over the world, including virtually all developing nations outside of a few in Africa and the Middle East.
Strictly speaking, the measure of fertility is the total fertility rate (TFR). The TFR is the number of children an average woman would have in her lifetime if age-specific fertility rates remained constant.

And even in tropical Africa, very high fertility rates have been declining in recent years. In 1980, in sub-Saharan Africa, there were seven births per woman. By 1990 fertility rates were 6.2. By 2007, there were only 5.3 births per woman in over thirty nations in sub-Saharan Africa, only six had fertility rates of 7.6 by 2005.

Very low income nations in Africa-including Chad, Mali, Sierra Leone and Nigeria-still have very high fertility rates. The Niger example is instructive. According to the World Bank, Niger (with per capita income of less than U.S.$300) is one of the poorest, if not the poorest nation in the world. [footnote] Niger’s population grew from 9.2 million in 1995 to 17.0 million in 2013, an annual rate of increase of 4.2%. Death rates are high because of a chronic shortage of food. But fertility in Nigeria in 2013 stood at 7.6 children per human, the highest on earth.
World Bank, *World Development Indicators 2011*, Washington, DC: World Bank; World Bank, *World Development Report 2013*, Washington, DC: World Bank.

In Niger, poverty interacts with very poor access to contraception and culture to yield the very high rate of fertility. Only 12% of women of child bearing age in Niger use contraceptives, versus about 50% of women in the

African nations of Rwanda and Zimbabwe. In addition, men in Niger tend to have multiple wives. According to the London Economist, local physicians maintain that wives in polygamous marriage there often seek to prove their worth by outdoing each other in child birth.[footnote]
The Economist (2014, August 16), “Population Explosion: Runaway birth rates are a disaster”.

Thus, although there are important exceptions, the worldwide decline in fertility has been nothing short of remarkable. In nearly 200 nations for which the World Bank has data, fertility declined in all but six. Of the six, four nations had constant fertility rates. Only two nations had increased fertility. These were France and the Netherlands. There was a slight increase in both these nations because their fertility rates before were already very low in 1990 (1.8%) and because they enacted incentives for higher fertility in the 1990s.

The world average for fertility rates had fallen to 3.2 by 1990 and to 2.5 by 2007. For low and mid-income nations, the rates fell just as sharply between 1990 and 2007, from 3.5 to 2.7. The average for high income nations was 1.8, well below the replacement rate.

We note that fertility rates in emerging nations are generally below 3 and still falling. But in the 1970s, fertility rates were much higher, and so were population growth rates. From 1965-1973 population growth rates in emerging nations averaged 2.5% per year.

Dire predictions by experts were then plentiful: world population was going to explode. But new evidence on fertility behavior over time shows how careful we need to be in making population forecasts.

Recent experience with falling fertility in richer countries has led to the view that they are beginning a state of reproductive collapse, and that this will also happen to many emerging nations. South Korea and Japan are often cited as existing examples of reproductive collapse, while China, as a result of the “one-child per family" policy, possibly, is cited as a future example.

Fertility trends interact closely with per capita income growth, life expectancy and education. Comparing a country's total fertility rate with the United Nation Human Development Index (HDI) testifies to the interaction.

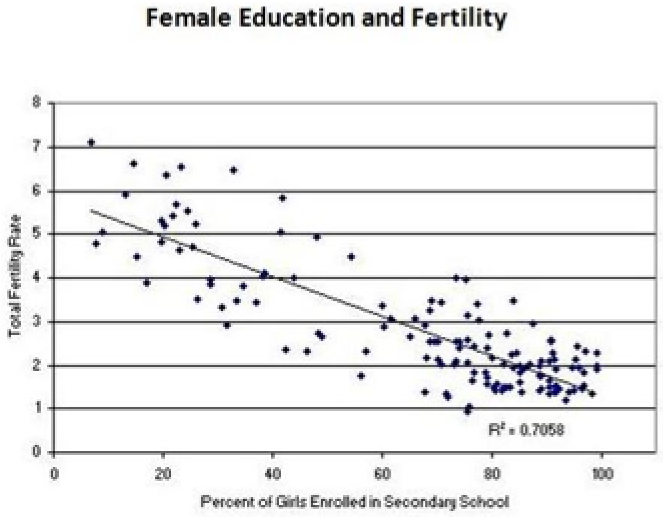
The HDI Index has 3 components:

1. Income per capita
2. Life expectancy
3. Level of education

We note that the value of fertility rates comes at about 0.80 on the HDI index. Many of the factors affecting fertility may now be better understood thanks to the ambitious and successful efforts by the World Bank and the U.N. to compile data on, not only population growth, but also education and trade.

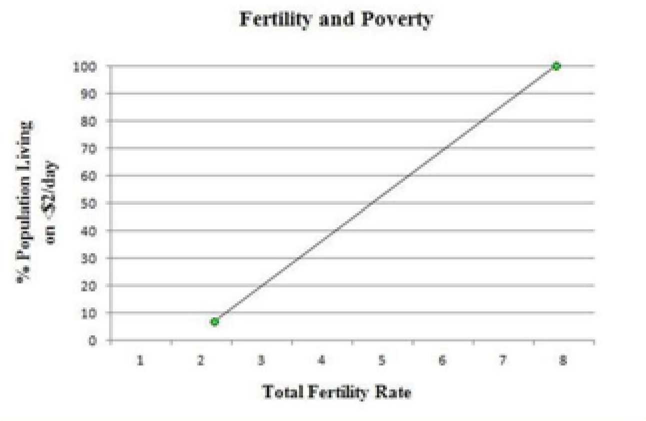
The proportion of girls in secondary school significantly affects fertility, as depicted in [link].

Growth that elevates people out of poverty plays an important role as well. See [link].



(160 observations)

Source: EPI from UNESCO



However, even though fertility has been sharply declining worldwide, world population, especially in emerging nations, will continue to grow for a few more decades, even if worldwide fertility rates were to fall to the replacement rate (2-1 children per female).

This will be because of the momentum factor, which is due to the fact that today's children outnumber their parents because of past high (but declining) fertility, will become tomorrows' parents.[footnote] This pattern is starkly evident in Vietnam, where the percent of the population aged 30 and less is almost double that of the population cohort above age 50. In Vietnam and many Latin American nations, for example more and more young people born in the past two decades are beginning to enter their reproductive years. This group is expected to account for 80% of the world population growth over the next few decades.
For a full examination of the momentum factor, see Dwight H. Perkins, Steven Radelet & David L. Lindauer (2006), *Economics of Development* (6th edition), New York, NY: W.W. Norton & Co.

My own view, based on almost fifty years of research and service in emerging nations, is that there are five prime factors in the recent striking decline in fertility in developing nations:

1. Rising female participation in the labor force. Where this has not occurred, as in Saudi Arabia, fertility rates remain very high. (Note: Rising female participation in labor force is both a cause and a consequence of economic growth.)

2. Rising levels of educational attainment, especially for women, has greatly affected fertility in developing nations. This too is both a cause and a consequence of rising economic growth.
   Higher levels of primary and secondary schooling leads to more informed choices about everything, including reproduction.
   Also higher female participation in labor force.
3. Economic growth and development itself (higher economic growth rates) have clearly led to declining fertility rates.
   Why? Because growth in per capita income causes higher income families to have less need for children to provide income and especially support old age.
4. Family planning programs especially in Asia and most of Africa have greatly increased the availability of various contraceptives, especially condoms (except in places such as Niger, where the lack of adoption of readily available contraceptives has kept fertility rates very high). Elsewhere, women in families who wish to limit family size can now much more easily access contraceptives.
5. Increasing urbanization. This factor is becoming increasingly more important in fertility decline. Consider what has been happening in urbanization especially in emerging nations.

In 2010 there was a worldwide crossover point: by that year urban population became greater than rural population.

China passed the crossover point in 2011. This would have been unbelievable even in the year 2000. There are now more Chinese in urban than rural areas, after two millennia wherein China was predominantly rural.

In any case,population movements in China in the past 100 years have been sizeable in any case. It is also worth noting that Chinese history in the last 100 years has many examples of major intranational migration: for example, movements of people to Manchuria in the North. While the Manchurian population in 1900 was 7 million, in 1992 it reached 22 million, a 3-fold increase.

To return to the present: the whole world has been urbanizing rapidly especially in developing countries.

Urbanization is a phenomenon that is both a blessing and a curse. It is a blessing because it makes possible strategic and lower cost concentrations of brain power, artistic talent and manufacturing materials. It is a curse because of the implications of urbanization for traffic congestion, urban crime, air and water pollution and, often, mental stress.

Urbanization is nothing new. For the past century, the world has been in the grip of a truly massive shift from rural to urban society. Far from subsiding, this demographic shift is accelerating. In 1900 only 14% of the world population resided in urban areas, compared to more than 50% of the world population in 2010.

The most credible census estimates suggest that 20 years from now, two-thirds of the world population will be urban dwellers. In 2007, only one city — Tokyo— had more than 20 million people. In 20 years, at least seven of the world’s cities will have 20 million people or more; none of these seven will be in the United States.

Why is urbanization another reason for the widespread decline of fertility?

In rural areas, children were long seen as needed for production. But children are relatively more expensive in urban areas. This affects fertility decisions in a major way. Recent fertility declines in Africa have been most dramatic in urban areas. The probable reason is growing relative costs of child-rearing in urban areas. More has to be invested in each child than in rural areas to allow them to grow up.

It is worth noting that a February 2008 article in Science Magazine argued that the growing costs of child rearing reflects (mainly) rapidly growing parental investment in children in urban areas.

Other factors associated with fertility decline accompanying urbanization are:

- Overcrowded housing and costly housing.
- Lower marriage rates in urban areas.

The Momentum Factor: Given the recent very sharp declines in fertility and mortality, the population of world will continue to grow for a while, probably from seven billion today to over nine billion in 2050, furnishing many more potential residents of cities.

The point: The world population will continue to grow long after replacement fertility rates have been reached in emerging nations. In fact, fully 70% of future world population growth will take place in only 20 countries in sub-Sahara Africa and Asia (excluding China).

Further Perspective on Convergence

Fifty years ago there was widespread optimism that living standards across the world would converge → a world of essentially similar income levels.

Convergence did in fact occur in growth rates of developed nations between 1870 and 1990. Significance of 1870? What occurred then?

1. The Meiji Restoration in Japan (1868)
2. The unification of German State after French -Prussian (1860)
3. The end of U.S. Civil War (1865).

Convergence among Western nations did occur from 1870-2000 developed Convergence: U.S. grew at average annual rate of 1.7%, while 17 other developed nations grew at 1.6%

But, until 1990 there was divergence big time (not convergence) between

This began to change (after 1980, and the reforms of Deng Vio Peng.

Generally from 1820-2000, the ratio of per capita income between the richest and the poorest countries increased by almost a factor of five.

In recent years, as noted earlier, this ratio has been declining. By the end of this collection you will likely understand a great deal about how this came about.

GLOBALIZATION

Introduction

The prime focus of this chapter is upon the process of globalization that has, among other things, materially increased connection between world markets and economies since about 1980. As we shall see, globalization has had many important dimensions. One of the most significant of these has to do with certain aspects of income distribution. The following chapter is concerned exclusively with income distribution generally. The difference between the two chapters is as follows: discussion of income distribution in this chapter centers upon "betweencountry inequality, the gap between rich and poor nations". Chapter 4 deals primarily with income distribution issues within nations: the share of national income received by individuals in the top, middle and bottom income ranges. There is necessarily some overlap between the two chapters, but this is not only unavoidable, but desirable. We will see that the most recent wave of globalization, contributed to a decline in income inequality between rich and poor nations, but higher income inequality within countries.[footnote]
Source: OECD 2014.

Globalization

Since 1995 the international press and many learned journals have been filled with articles on globalization, often with exaggerated estimates of the degree and effects of globalization. In recent years, globalization has become something of a cliché. It has sometimes been depicted as a magic potion or a poison, depending on one's political views. It is neither.

Globalization strictly speaking began 60,000 years ago when the first humans walked out of Africa. It has waxed and waned ever since. The Phoenicians began international trade with tin brought from Wales in Bronze Age (3,000 B.C.E). Marco Polo, who fashioned trade deals in India and China, was a forerunner of globalization and he was there just before the Ming Dynasty Empress started burning ships in 13th century China.

Globalization continued in the 14th and 15th centuries. Then, Imperial China became highly dependent on New World plants and Peruvian silver. The latter ultimately weakened the Ming Dynasty.[footnote] Not only that, but after 1492 human-powered exchanges of populations, species and genomes from the New World to the Old had far-reaching consequences for ecology as well as markets. To illustrate only 30 years after Pizarro overthrew the Inca Empire in the 16th century, Spanish farmers were exporting potatoes to France. But the potato was indigenous to the Andes. In turn, it has been estimated that 20% to 30% of world population increase from 1700-1900 was due to better nutrition from the spread of the potato.[footnote]

Jared Farmer (2011, November 4), “Pangaea Penultima”, Science, 334(6056): 600-601. Ibid, p.602; see also Dennis Flynn and Arturo Giraldez, “Born With a Silver Spoon: The Origin of World Tade in 1571,” Journal of World History 6:2 (1995).

Nathan Nunn and Nancy Qian (2011), “The Potato's Contribution to Population and Urbanization: Evidence from a Historical Experiment,” *Quarterly Journal of Economics*, 126(2): 593-650.

Globalization in 2014 means different things to different peoples. To some it means the rapid spread of culture and ideas in a world wired tightly together by the internet.[footnote] To others it means growth of international travel and tourism.

By 2014, the number of websites worldwide surpassed 1 billion.

In a course on economics, an economic definition of globalization should be used. Simply put, globalization is “the increasing inter-dependence between nation’s economies, as measured by greater flows of goods, services as well as cheap tools of communication and capital across national borders, indeed globalized communications. There is even mobile network service at summit of Mount Everest, so climbers can call home from the summit.

Popular discussions of: “globalization” imply that it is something of a new phenomena. It is not. In its present incarnation, it began after about 1980. But there was a previous, huge wave of modern globalization between 1840 and 1914.

Between 1870-1914, world trade grew very rapidly, from 10% of world GDP to 21% of world GDP[footnote]. Global capital flows, especially to the U.S. and some Latin American nations (especially Argentina) also grew rapidly. In 1870, foreign direct investment (FDI) in "developing nations" in Africa, Asia and Latin America was only 9% of the total output of these Nations. By 1914 the percentage reached 33%, a 3 ½ fold increase.
"The Rise and Fall of World Trade", NBER Reporter, Winter 2005/2006, pp.20-21

However, it is important to understand that there were material differences between the first big wave of modern globalization and the most recent wave, extending into the second decade of the 21st century. The first wave was impelled by growth in international foreign investment. The second wave included much more financial integration across countries, as well as growing trade and investment flows.

The first wave of globalization paused abruptly in 1914 by World War I. The coup de grâce was the great depression when world trade shrank precipitously after 1929 to only 9% of world GDP by 1938. Trade fell so sharply that many in the U.S., especially politicians, began to think of the U.S. as a mostly closed economy. In their view, the role of international trade and capital movements were seen as largely inconsequential for the U.S. economy.

Even in the two decades after World War II, in the U.S. and Europe most econometric models depicted a closed economy. This might have been acceptable in 1955 when U.S. international trade was only 6% of GDP. By 1992[footnote], trade was 27% of GDP and remained there through 2011. Open economy models not closed economy models are needed in these circumstances.
NBER Reporter, Winter 2005/2006, p.20.

In sum, in the immediate years of World War II (1945-55) "closed economy" was not too bad an assumption. Foreign trade was a very small percent of GDP in U.S., and capital movements were then almost all one-way, from U.S. to rest of world. Economists liked the closed economy because it was simple to model: the math was easy. Because the dominant models were closed, people were led to believe that trade and capital flows could be ignored in economic model-building, as well as in policymaking in taxation and trade.

But as the world moved into the 1970s, 1980s, and 1990s, the closed economy assumption became increasingly untenable for the U.S., Europe, Japan and other industrial nations. It was never tenable for small emerging nations (except the small number of deliberately closed economies such as North Korea and Burma) as we shall see in Chapter_____.

In the 1980s and 1990s economists began to understand that exports, imports, and capital flows were increasingly important determinants of economic growth worldwide. That is, globalization was “rediscovered” about a quarter of a century ago.

Parenthetically, we note that the surge in international trade and capital-flows in the period 1890-1914 was, relatively speaking, even more significant than in the late 20th century relative to the size of the economies then. The impetus to earlier globalization in the 19th and early 20th century was perhaps due to three more factors:

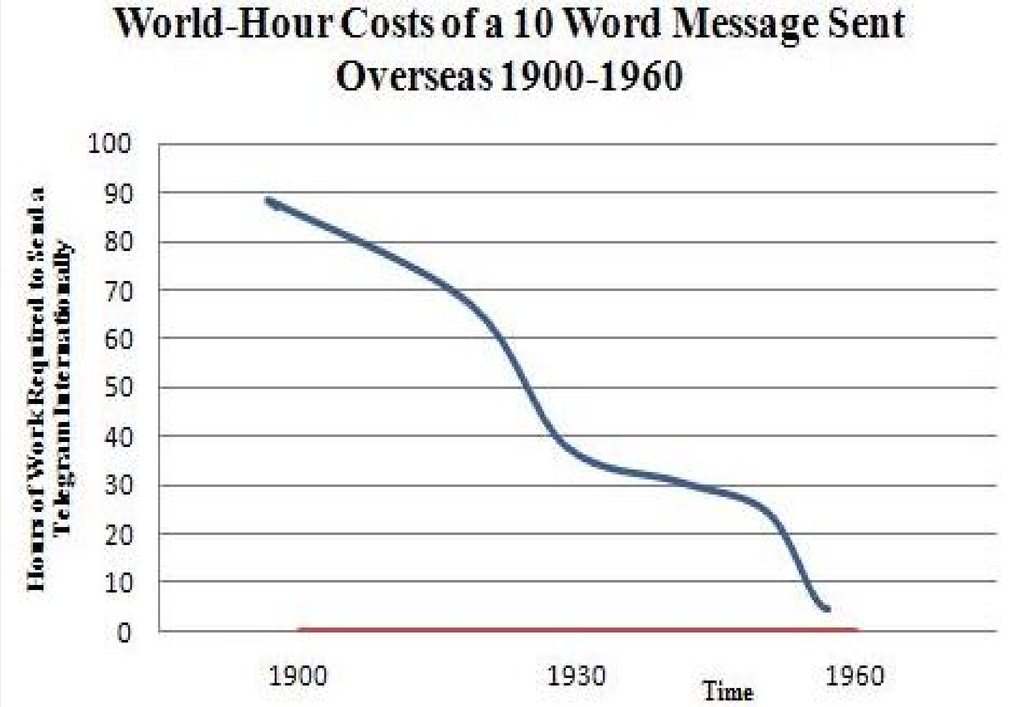
1. Sharp declines in communication costs and the rise of newer technologies in communication (telegraphy, telephone). (Figures 3-1, 3-3)
2. Steadily falling transport costs (railroad, clipper ships) declining trade barriers, rapidly growing foreign investment in the U.S. and poorer nations. (See Figure 3-2).
3. Mssive migrations after 1848. Example: in Ireland population fell by 45% from 1860-1914 as Irish left for the U.S. In the same period, millions of Italians emigrated to France, Germany and Switzerland, as well as the U.S., while millions of Chinese and South Asians migrated to Southeast Asia and the Caribbean.

Consider the role of falling costs of transportation and communication in the latter stages of the first wave of globalization (1880-1914) and the years just prior to the second wave.

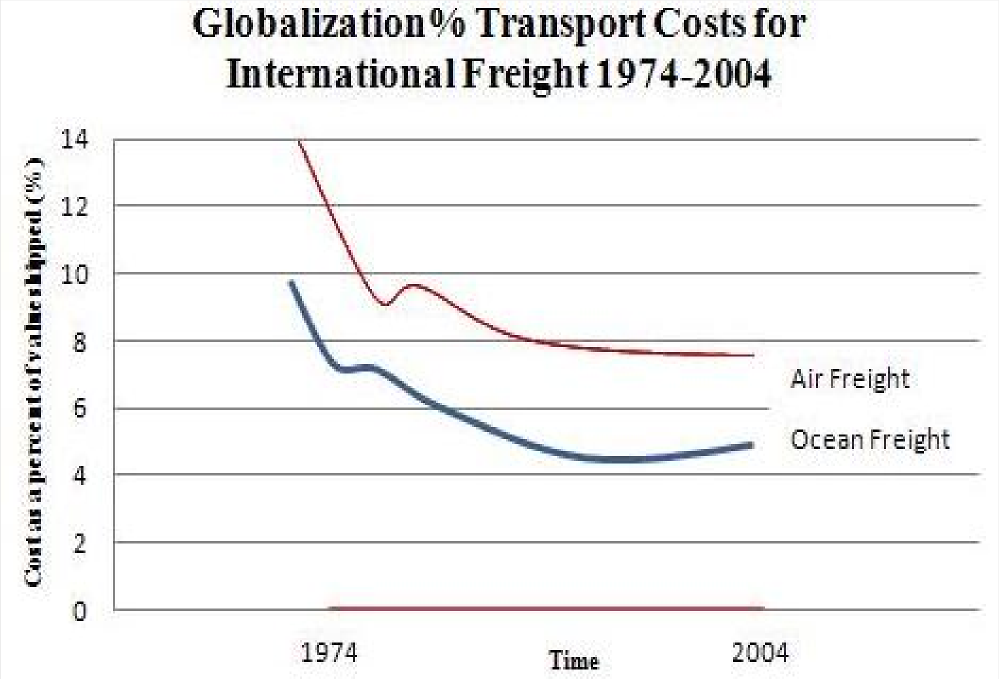
The invention of the telegraph not only spelled the end of the “pony express” in the U.S. a few years after the civil war, but the telegraph vastly enhanced both national and international communications.

Examples:

Note:
In 1453 it took 40 days for the Pope to learn that Constantinople (Istanbul) had fallen to the Turks. By 1869, like the internet today, the telegraph was changing everything. Before, war and conflicts were reported with a lag of a week or so (within Europe) to two months (between Europe and India). And now we have almost instantaneous fully ubiquitous communication (Facebook, Twitter etc.).
Figure 3-1 depicts the very sharp decline in the costs of sending telegraph messages overseas. Here, these costs are measured by the number of hours of work required for the average person to send a telegram overseas. These costs fell from about 100 hours in 1900 to less than 3 by 1960, a year in which telegraph and telex messages were still widely used.



Note:
In the second wave of globalization, declines in costs of sending international freight combined with very marked drops in the costs of international telephone calls and the marked rise of e-mail traffic to create an environment conducive to the rapid growth in international trade and capital flows.
Figure 3-2 attests to the very substantial cheapening of transport costs internationally from 1974 to 2004.



Costs of air freight fell from 13% of value shipped in 1974 to 9% in 2004. Costs of ocean freight fell from 10% of value shipped to about 6%.

Note:
Finally, the recent (post 1990) very rapid rise of internet communication, involving very high speeds at very minimal costs per message, has been transforming commerce. Total e-mail traffic rose from less than 1 trillion messages in 1995 to well above 12 trillion in 2010, and the number continues to rise rapidly. Further, the number of websites surpassed 1 billion in July 2014 and is also growing at rapid rates.

In any case, the most recent wave of globalization that has drastically altered the face of the world economy since about 1980. The world economy of 2013 bears little resemblance to the world economy of 1950, or even 1980: consider this very short summary of the rapid evolution of the world economy under recent globalization.

Many countries were flat on their backs after World War II and the Korean conflict. At that time they had few good prospects. Some have now become powerful economic engines. Some are surprises; some we now take for granted. In the latter category: in 1954, South Korean per capita income was equal to Zambia's per capita. By 2005, Korea's per capita income was 39 times that of Zambia. Korea, with 1/20 the population of India, had a GDP total size almost equal to that of India in 2005. India itself has done well since it began its slow process of deregulation two decades ago, moving away from the "license raj" of 1947-1990.

In 1982, China's per capita income was equal to India's. Today, even with India's strong economic record since 1990, Chinese GDP per capita was twice that of India. We can place the Chinese experience in further perspective. A favorite Mao Tse Tung slogan was: "surpass Britain, then America." In 2007 China's economy surpassed not only Britain but also France in size. China has the 2nd largest economy in the world and could surpass the U.S. in size by 2030.

Consider also Southeast Asia—almost all countries there have prospered as never before. In the period 2005-2008, Indonesia, Malaysia, Vietnam all had growth close to 6%. Thailand was a laggard: "only" 4.7% percent.

In Latin America Chile displayed unusual economic strength from 1983-2014. Brazil has been growing but began sputtering in 2013. Argentina is sliding toward yet another collapse (a recurring development since Dictator Juan Perón's first term in power beginning after World War II). Bolivian development has once again stalled, while Hugo Chavez and his successor ruined the Venezuelan economy. Mexico struggles with deep divisions, but has experienced growth in recent years.

What of Europe under globalization?

“Eurosclerosis” gripped the continent for the years from 1990-2005. Per capita GDP in the continent’s three largest economies before 2007 had been falling relative to the U.S. On average, per capita income for Germany, France and Italy together was 80 percent of the U.S. in 1990. By 2005, per capita income in these three together was only 68 percent that of the U.S. If current trends continue, the average U.S. citizen will be twice as rich as a German or Frenchman by 2025. Since 2011, significant growth in Germany has resumed. Except for Germany, and to an extent Poland, Europe has experienced relatively few benefits of recent globalization.[footnote]
See Alexandra Spitz-Oener, et al. (2014, Winter), “From Sick Man of Europe to Economic Superstar: Germany’s Resurgent Economy”, *Journal of Economic Perspectives*, 28(1): 167-188.

There are many reasons for the pattern depicted above. One of the most important has been ossified labor markets in France, Italy, Spain, and Greece. In all these countries, it is almost impossible to dismiss anyone when business declines. And it is generally recognized that there is overregulation generally: with overregulation markets cannot be fluid and adaptable.

Meanwhile, Japan’s economic performance in a globalizing world has been uneven to say the very least.

From 1950 to 1990 Japan was viewed internationally an economic powerhouse. In the early fifties, per capita income was only 20 percent of that the U.S. By 1991 per capita GDP in Japan was equal to 80 percent of that of the U.S. Then, the Japanese economy entered a long night. By 2004, Japanese income per capita was only 71 percent of the U.S. From 1991 to 2002, Japan suffered 66 consecutive months of recession versus only 16 in the U.S. However, from 2003 to 2008 Japan enjoyed four consecutive years of positive growth only to decline, along with all industrial nations, because of the 2008-2010 economic meltdown. By 2014 Japan’s very low fertility rate caused a serious aging problem in the labor force, with steadily declining numbers of new workers entering the labor force.

Two waves of globalization brought unforeseen change to the U.S. In the first wave in the 19th century the U.S. was a major debtor nation as a consequence of large flows of foreign investment and foreign loans to the

U.S. to finance “internal” improvements such as roads, canals and railroads in 1830-1860. By 1860, the U.S. accounted for the largest stock of foreign investment national and gross foreign liabilities (loans, FDI). But, U.S. also had the largest stock of gross foreign assets (or investments overseas). Nearly a century later, after World War II, the U.S. became the biggest creditor nation.

In the most recent wave of globalization it is probably safe to say that there have been two defining elements:

1. The enormous increase in the volume of international trade. Over the past 25 years, the rate of increase in trade has vastly outpaced the rate of growth of world GNP.
2. The increasing mobility of financial and physical capital across national borders. Capital flows from nation to nation are far larger and much freer today than in 1950, as countries, including the U.S., European states, and dozens of developing nations, liberalized their capital accounts especially in the 1980s and 1990s.

Japan and Taiwan, until recently, were major exceptions: only reluctantly have they liberalized capital inflows and outflows, and not to the same extent as many emerging nations. Liberalization of capital accounts means reduced controls on movement of capital in and out of countries by relaxation of strict foreign exchange controls.

We mentioned earlier in the chapter that much of what has appeared about international capital flows in the popular press about globalization is misleading, especially about international capital flows. Much of the increases in capital flows has been between rich countries. Indeed, in 2007 foreign investors increased their acquisition of corporate assets by 90% in one country: the United States. In fact, the developing world’s share in global private capital flows fell from 12% in 1991 to 7.6% in 2000.

It is important not to overstate the extent of globalization in the world economy. True enough, the world economy is much more interdependent than in, say 1960, but, consider that as late as 2010:

- Only 3 percent of people live outside their birth nation.

- Only 7 percent of rice is traded across borders.
- Only 1 percent of U.S. companies have foreign operations.
- FDI (foreign direct investment) accounts for only 9 percent of worldwide investment.
- Only 20 percent of shares traded on the U.S. stock market are bought by foreigners.
- And, because of the global meltdown beginning in 2008, the flow of FDI fell from $2 trillion in 2007 in 2007 to $1 trillion in 2009.

These caveats aside, globalization involves ever more tighter links between rich nations. There are now published indices of globalization. One widely used index is published by Foreign Policy.[footnote] To rank nations, the following indicators were employed:

1. Degree of Economic Integration -the share of trade in GDP and value of direct foreign investment
2. Technological Connectivity -extent of internet users, internet hosts and XXXX services
3. Personal Contact-international travel and tourism, international telephone traffic and remittances abroad
4. Political Engagement-membership in international organizations, financial contribution to U.N., World Bank, etc.

See *Foreign Policy*, June 2007.

Using these criteria, the most globalized economies in 2010 were

1. Singapore
2. Ireland
3. Switzerland
4. the U.S.

(Note: All the Nordic nations were in the top 15)

The most “globalized” of developing nations was Malaysia at #19. Note: Japan was only #28. France and Germany were only 18th and 21st. In this ranking, Russia was #52,and China was #54, but China was rising.

Globalization involves large benefits to some, costs to others. Thus, we must ask if globalization is, on balance a good thing or not? The answer depends on your perspective. First, globalization and increasing capital mobility cause economic shocks to be transmitted more quickly and fully across borders. This makes it even more difficult than in 1970 to conduct effective monetary and fiscal policies in all nations. Also, a very substantial number of jobs have been lost in rich countries because of globalization, as some industries in developed nations cannot compete with growing imports from emerging nations.

On the other hand, consider that since 1990, globalization has lifted more than 500 million poor people out of abject poverty, in China and India alone. Never before in history has this happened. Still, there remains over 1 billion living in poverty in China and India together.

Also consider the comments of Larry Summers, former Treasury Secretary and Chief Economic Advisor to President Obama (2008-2012). In his view there is a big paradox regarding globalization: even its winners see themselves as losers.[footnote] Indeed, while there is little doubt that globalization has given rise to imbalances and inequities across nations, it is still unclear how much of this is due to globalization and how much to other factors, such as technological change.
Lawrence Summers (2006, October 29), “The Global Middle Cries Out for Reassurance”, *Financial Times*.

There are clear benefits of globalization to the U.S., Europe and Japan. Growing trade with emerging nations has allowed prices of consumer goods to be slashed, from clothing to electronics. This has placed what once were considered luxury goods into the hands of tens of millions of lower income people. For this reason globalization might be considered, at least in part, a “pro-poor” development for the U.S. Also, competition from such emerging markets as China and India has spurred many developed nations on to greater productivity and innovation. Finally, recent research indicates that globalization has had a positive impact on productivity in large R&D (research and development) firms in the U.S. and Europe.[footnote]
Michele Cincera & Julien Ravet, “Globalization, Industrial Diversification and Productivity Growth in Large European R&D Companies”, *Journal of*

Productivity Analysis, April 2014, Vol. 41(2): 227-246.

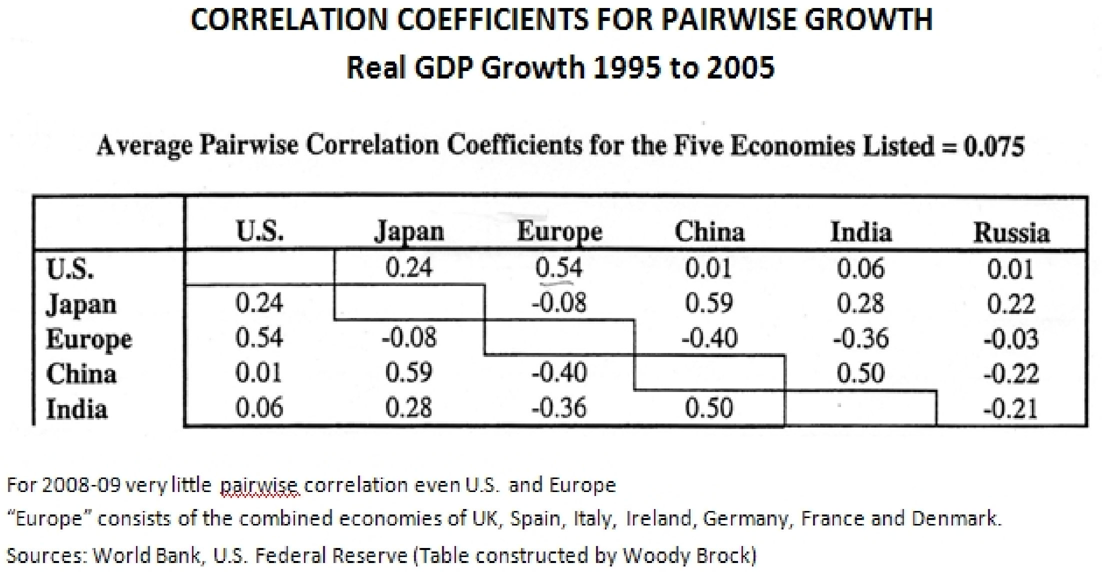
Nevertheless, as Summers notes, the global middle class may perceive themselves as losers from globalization.

Measuring Globalization

The degree of globalization, while very substantial, is often overstated. If the extent and penetration of globalization were as great as commonly thought, then an average pairwise correlation coefficient of GDP growth across today's five largest economic areas should be high on the order of 0.6 to 0.7. That has not happened.

Consider the table below, containing pairwise correlation coefficients for the U.S., Japan and the six largest European nations combined, plus China, India and Russia for years 1995-2005.

The average is 0.075, about 1/9 of the usual expectation.



CORRELATION COEFFICIENTS FOR PAIRWISE GROWTH

Real GDP Growth 1995 to 2005

Average Pairwise Correlation Coefficients for the Five Economies Listed = 0.075

	U.S.	**Japan**	**Europe**	**China**	**India**	**Russia**
U.S.		0.24	0.54	0.01	0.06	0.01
Japan	0.24		-0.08	0.59	0.28	0.22
Europe	0.54	-0.08		-0.40	-0.36	-0.03
China	0.01	0.59	-0.40		0.50	-0.22
India	0.06	0.28	-0.36	0.50		-0.21

For 2008-09 very little pairwise correlation even U.S. and Europe

"Europe" consists of the combined economies of UK, Spain, Italy, Ireland, Germany, France and Denmark.

Sources: World Bank, U.S. Federal Reserve (Table constructed by Woody Brock)

Globalization and Fertility

We return to demographics in considering the costs and benefits of globalization. The decline in fertility rates has been worldwide, but the sharpest decreases have been in East Asia, where rates dropped from 5.4% in 1970 to 2.1% in 2011. But rates also fell substantially in South Asia: from 6.0% in 1970 to 3.1% in 2011. Fertility rates in Africa were high in the 1960s (between 5.5% and 7.5%, about the same as Indonesia and Mexico). But while Asian and Latin American nations' fertility rates declined steadily after 1970, African rates remained high until very recently. And there has been great variation in fertility rates within Africa: By 2012, only 13 African Nations had fertility rates below 4.0. None of these countries are in East, West or Central Africa. Another 15 African nations have fertility rates between 4.0% and 5.0%.[footnote]
Jean-Pierre Guengant and John May, "African Demography," *Global Journal of Emerging Market Economies*, 2013.

Notice something about these figures for fertility across regions of the world. The largest declines in fertility have been in those emerging nations most involved in globalization, especially those in East Asia (China, Indonesia, and Thailand). The smallest decline in fertility rates was for countries that through 2011 have been least involved in globalization (sub-Saharan Africa). Globalization seems to lead to a shift in the direction of replacement fertility, the rate at which population eventually stabilizes. One reason may be that in countries that have "opened themselves up", families do not need a lot of children for insurance; instead they may rely on urban jobs or services in rural areas.

Consider now a topic increasingly discussed in financial and political circles:

Globalization and "Decoupling"

In 2009 at the beginning of the most recent world recession, doomsayers were predicting a very sharp collapse in the entire world economy. And even in fast-growing countries like China, Korea, Indonesia, Singapore and

India, growth did slow down temporarily. But by the second quarter of 2009 growth in emerging East Asian nations was 10% on an annualized basis. Also, Asian stock markets were up sharply in 2009: for example, stock market values increased in Indonesia 80%, China 75%, and South Korea 40%.

But at the same time, the economies of the U.S. and the other six big, rich countries contracted 3.5% in 2009. Some have argued that there has been process involving some kind of "decoupling" of economies and growth rates, in spite of claims of growing convergence in economic development.

But we should not be surprised that Asian economies recovered much more quickly than the U.S. and Europe. There were at least four reasons for this, none related to "decoupling":

1. Asian households had debt burdens well below those of the U.S. and Europe. U.S. and European householders had to "dig out" of deeper holes than households in Asia.
2. Asian households have long been saving a much higher percent of income than those in the U.S. and Europe. Savings rates in China reached 40% in the early 2000s, more than double that of the U.S.
3. Asia's governments entered the downturn with much stronger government finances and lower national deficits (U.S. deficit 2011: 12-13% GDP)
4. Asia's banks did not join in the debt frenzy that did in so many U.S. and European banks did. (We conclude that excessive leverage (debt) was the prime cause of the 2007-2010 worldwide meltdown.

So Asia displayed prudence in households regarding debt and savings. Asian governments showed prudence in avoiding budget deficits before 2008, and Asian banks showed much more prudence in lending than in the U.S. and Europe. This is noteworthy, since there has been a tendency in the U.S. and Europe to view prudence as primarily a western value.[footnote] Nevertheless, economic prudence has been much more evident in East Asia. See Max Weber(1930), *The Protestant Ethic and the Spirit of Capitalism* London: Unwin University Books. See also R.H. Tawney (1926), *Religion and The Rise of Capitalism* London: Harcourt Brace.

In any case, we have seen that, however measured, the results of globalization have so far been mixed. One response, coming from those who have incurred costs, such as labor unions in the U.S. and Europe, has been pressure for a return to protectionism, especially more restriction on imports from China, Brazil, Columbia and other emerging nations.

However, except for some labor unions in U.S., France and other rich nations, most critics of globalization agree that more protectionism is not a constructive response to globalization. And we will see that protectionism often leads mainly to self-inflicted wounds.

Above all, one fact seems indisputable: If economic growth is viewed as a "good" thing, it should be to understand that sustained growth requires that a country leverage the resources and technology of the global economy. There are no known exceptions to this rule. China has proven this emphatically.

Globalization and Inequality

Overall, global inequality has declined with globalization, in that the distribution of income has narrowed as between rich and poor nations. [footnote] At the same time, globalization gains come with costs. These include:

- First, a mixed picture as to income distribution within poor nations. While there is some evidence that globalization has helped reduce income inequality within poor nations, there is also evidence that from 1998-2008 income growth in the middle percentiles (35th to 70th) was materially faster than for the lowest 4 deciles).[footnote] Branko Milanovic and Christopher Lakner, "Global Income distribution: from the fall of the Berlin Wall to the Great Recession," *World Bank Working Paper #6719*, Washington, DC: World Bank, 2013.
- Second, there has been some rising inequality of income within rich countries, such as the U.S. and Britain, due only partly to declining income of the bottom of the income distribution (see the next module).

Effects of globalization on income distribution are discussed more fully in the next module.

Interesting fact: The number of (U.S. dollar) billionaires in the world rose from 400 to 1996 to 1,000 in 2010 (Forbes). But after 1996 the fastest growth of billionaires was in the BRICs (Brazil, Russia, India, and China). This group of nations had about 220 billionaires in 2010, compared to almost NO billionaires in 1990.[footnote]
Forbes Magazine.

Within emerging nations consider experience with China and Mexico. Globalization (greater economic openness) has apparently contributed to rising inequality in some nations, including China and Mexico. Recall:

The Gini Index (coeffiencies) for both countries has risen. In China, it rose from 30 in 1982 (beginning of reforms leading to more openness) to 40 in 2005.

The increase in Mexico was slight. Gini was 45 in 1982. By 2005 it was 46.

The biggest winners in both countries: skilled workers, the biggest losers in both countries: unskilled workers.

What about developed nations?

In the past 35 years the share of the top decile in the income distribution in most of continental Europe (except France) and Japan increased hardly at all. But in 3 Northern-Hemispheric, English-speaking nations: Britain, Canada and the U.S. the share of the top decile increased notably.

In the U.S. the top deciles share was 33% in 1972, then rose to 42% in 2008.

And significantly, the share of top 0.1% of income earners in all the English speaking nations rose sharply from 2% of income to 5.5% of income.
[footnote]
See Thomas Piketty, *Capital in the 21st Century*

What caused this? Lower taxes on the rich? More income to capital owners? According to some, the cause has been sharply increased rewards to the "Working Rich." This group includes professional athletes, plaintiff lawyers, CEOs of fortune 500s). This group replaced capital income earners at the top of income distribution in English speaking nations.[footnote]
Piketty, Ibid.

The reasons for this development are still unclear, though globalization does seem to be part of the answer. Technological change is also part of the answer. But much is still unexplained. "Tournament Economics", wherein the "winner takes all" in competition for top global positions, may also play a role.[footnote]
Robert H. Frank, Philip J. Cook, (1996 September 1), *The Winner-Take-All Society: Why the Few at the Top Get So Much More Than the Rest of Us,* New York, NY:Penguin Books

Economists Sudhir Anand and Paul Segal conclude there is no consensus regarding the direction of changes in the Gini worldwide.[footnote] In the future, we will need to consider closely how globalization limits the ability of nations to reduce income inequality. Also we will later consider effects of the rebirth of state capitalism on income distribution, when we consider state-owned enterprises in the economies of emerging nations.
Anand, Sudhir & Paul Segal (2008, March). "What Do We Know about Global Income Inequality?" *Journal of Economic Literature*, 46(1): 57-94. DOI: 10.1257/jel.46.1.57.

Globalization and Future Income Redistribution

Why might globalization make future redistribution more difficult? That is, can nations do much to reduce inequality in a globalizing world?

Redistribution in the coming years will be more difficult if only because of the high degree of international mobility of capital. This makes it harder for governments to increase taxes on capital, because capital can migrate. Individual countries therefore lose some degree of freedom in policy-making.

But income redistribution will continue to be an important political issue, at least in democracies . Alexis de Tocqueville, a Frenchman, long ago presented interesting arguments about redistribution in his 1838 book, Democracy in America.[footnote]
Alexis de Tocqueville, "The Project Gutenberg EBook of Democracy in America", Volume 1 (of 2).http://www.gutenberg.org/files/815/815-h/815.htm

He wrote: “Democracy is safe until the politicians discover you can bribe people with their own money”.

Globalization: The Continuing Rise of China

Globalization has coincided with the emergence of China as a major importer from, and foreign investor in, emerging nations. In the past decade Chinese firms have been, by far, the largest investors in natural resource sectors in Sub-Saharan Africa. This was in fact a major issue in Ghana’s Presidential elections in 2012. In the past 5 years, Chinese investment in Latin American oil and gas, copper and other hard minerals has been accelerating very rapidly.

We are witnessing something never seen before, a giant country half very prosperous, and half very poor, moving rapidly toward technological military and economic parity with the west, so that within a few years China may again have the world’s largest economy, reclaiming the rank it had in 1820.

More generally, between from 1820 and 2000, the ratio of per capita income between the richest and the poorest countries increased by almost a factor of five.

In recent years, as noted earlier, this ratio has been declining. By the end of this collection it is hoped that you will understand a great deal about how this came about.

Finally, we will see in later modules that globalization has meant that economic shocks in one part of the globe travel much faster to the rest of the world than even 25 years ago. This makes the conduct of all economic policies even more difficult now than in past.

INCOME DISTRIBUTION

Overview

The central focus of efforts to foster economic growth worldwide has long been drastic reductions in absolute poverty: to lift people from low levels of nutrition health, housing and education.

There is abundant evidence that these efforts have borne fruit, especially over the past half century. For example, of the total number of the world's very poor in 1980, 323 million, or half were in India.[footnote]. But, since major economic reforms in 1992, nearly 190 million people exited from poverty by 2005. The Indian experience has been repeated in dozens of other nations: the proportion of families living below nationally-established poverty lines has fallen sharply since 1980.
Jagdish Bhagwati & Arvind Panagariya (2014), *Why Economic Growth Matters*, New York, NY: Public Affairs, p.247

The reduction of absolute poverty remains a primary aim in virtually all nations, save perhaps North Korea. However, governments in emerging as well as developed nations are clearly concerned not merely with absolute differences in income, but relative differences as well. The distribution of income matters greatly around the world.

For several decades after 1960, economists, utilizing the work of Harvard University's Simon Kuznets, believed that there was a necessary connection between economic growth and inequality. Kuznets held that as growth and development begins in a nation, inequality first tends to rise, largely because of a shift out of agriculture (low wages, but more equal wages) into industry (more unequal wages). But, as the nation develops, Kuznets conjectured that inequality would begin to fall. The Kuznets hypothesis (Kuznets curve) is not widely accepted today.

In several recent empirical studies there seem to be no necessary connection between rapid growth and rising inequality. Michael Bruno and colleagues instead found that in a sample of 44 nations from 1981-92, inequality slightly rose with higher rates of economic growth rates in 22 nations, but in the other 22 with higher growth, inequality actually fell.[footnote] And in the “Gang of Four” nations (Korea, Taiwan, Singapore and Hong Kong) very rapid rates of growth (>8% year over 3 decades) were associated with rising income equality, not inequality during the sixties and seventies. Michael Bruno, Martin Ravallion, & Lyn Square (1996, January), “Equity and Growth in Developing Countries”, Policy Research Working Paper No. 1563, Washington, DC: World Bank.

At least four factors seem to be positively associated with high growth and improving income equality:

1. Initial conditions: where the initial distribution of income and assets before growth takes off, is not highly skewed (leads to more equality later)
2. Human Capital: The existence of a high quality education system (conducive to greater equality).
3. Labor Intensive Growth Strategies: in which governments avoid underpricing of capital, leading to rapid employment growth (more equality)
4. Limited scope for rent-seeking activities and corruption: where damages from rent-seeking are held in check, whether by constraints on government corruption, the presence of a free press, or openness to foreign trade (rent-seeking is covered in the module entitled *Corrosion of Institutions: Rent Seeking*).

In this module, we seek to understand why and how income distribution is changing and to identify those types of government policies which can and cannot help rectify income inequality over time.

We will see, in this and in many following modules, that many policies used in the past that were ostensibly intended to improve income distribution have either had little effect or have, on occasion, actually worsened the problem. One policy, however, appears to have been successful virtually everywhere. In this and subsequent modules, we will examine the most potent policy for rectifying economic inequality: expansion in investment in human capital, especially education and public health. Some important implications of investment in human capital are covered in this module; a fuller discussion is presented the module entitled *Human Capital: Education, Public Health*.

Concepts for Understanding Income Distribution Issues: The Gini Coefficient

The Gini Coefficient

Traditionally, the best measure of income inequality or equality has been the Gini Coefficient:[footnote]
Also known as the Gini Index. The Gini ratio is a measure of statistical dispersion developed by the Italian statistician and sociologist Corrado Gini and published in his 1912 paper “Variability and Mutability.”

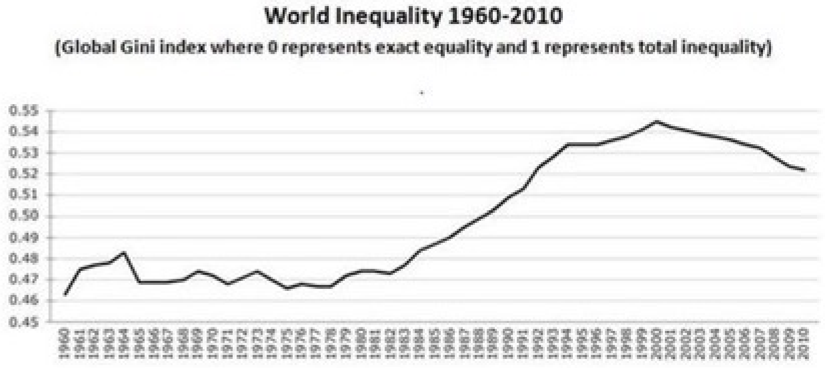
Gini=	0	Perfect Equality (everyone earns the same).
Gini=	1	Extreme Inequality (one person gets all the income).

Recent Experience: 1980s-2008

	1980	**2008**	

	1980	**2008**	
U.S. Gini	0.34	0.38	By one measure, some increase in inequality, continuing through 2013, to 0.44. (However, see estimates cited later in this module).
Germany Gini	0.26	0.30	Increase in inequality from a lower base.
China Gini	0.28	0.40	Large increase.
China Gini	0.58	0.55	Some decrease in inequality.

In 2000, Brazil had the most unequally distributed income in the world. But by 2008, income inequality there had lessened, partly because of Brazil's ambitious program of conditional cash transfers, involving direct payments to low income families with children in school.



The World Gini 1985 began rising in 1992, and then began a slight decline after 2000. Figure 1 displays the evolution of world inequality (or equality) from 1960 to 2012, as measured by the Gini coefficient. The graph shows more or less constant worldwide Gini coefficients after 1963 and until 1983. Then, income inequality began to increase. By 2000, the worldwide Gini reached a maximum of about 0.54, after which it began to slowly decline. What we observe in Figure 1 is entirely consistent with what we will find in the remainder of this module and indeed in this Collection.

Income Distribution Trends: Developed Nations

Efforts to understand the many complexities of income distribution issues in emerged nations may be enhanced by considering possible cause and consequences of rising inequality in the wealthy nations of Europe and North America. There are four reasons for this.

First, trends in income distribution in developed nations, may, in a globalizing world, presage what might soon occur in emerging nations. Second, the study of income distribution issues anywhere involves difficult empirical and methodological questions. If improperly handled, resolution of these questions can lead to unwarranted conclusions. Third, the literature on income distribution in developed nations is substantial, with important lessons for the interpretation of income distribution studies in emerging nations. Finally, recent research on income distribution shows that the observed distribution of income anywhere is greatly affected by how income is measured (pre-tax vs. post-tax, pre-transfer vs. post-transfer), and can materially affect conclusions about income distribution trends.

We will see that by some measures the distribution of income in many Western societies has become sharply more unequal since 1980, and that the position of middle income households has worsened. But, by other measures that are at least as legitimate, income inequality has grown only moderately, and in particular, middle income households, at least in the U.S., have had significant growth in income, but not nearly as much as that enjoyed by upper income households.

Using the most restrictive measures of income (pre-tax, pre-transfer income of households) we may note that by 2008, income inequality in the U.S. was as high as it was in 1908.[footnote] For emerging nations, the results are somewhat mixed, but new data indicate that income inequality has

decreased compared to 30 years ago, due to falling inequality between rich and poor nations.[footnote] In other words, the distribution of income between rich and poor nations moved in favor of the latter. However, there have been some notable exceptions such as China where the Gini increased 34% between 1978 and 2008. Indeed in China, the richest 10% in 2013 had incomes 13 times the poorest 10%, as compared to the U.S., where the richest 10% makes 5 times as much as the poorest 10%.[footnote]
Thomas Piketty (2014), *Capital in the 21st Century.* Trans Arthur Goldhammer, Harvard University Press.
Martin Ravallion (2014, May 23), "Income Inequality in the Developing World", *Science,* 334(6186): 851.
Mara Hvistendahl, (2014, May 23), "While Emerging Economies Boom, Equality Goes Bust", *Science,* 344(6186): 832-835.

The share of the top 1% worldwide is particularly significant. Available evidence indicates that income inequality has increased in developed nations over the last 3 decades, especially in English speaking countries, and particularly in the United States, whereby one measure of the share of the top 1% of income recipients has more than doubled.[footnote] Other countries, including Japan, France and Germany[footnote] have exhibited growing inequality, but not nearly on the scale experienced in the U.S.
Facundo Alvaredo, Anthony B. Atkinson, Thomas Piketty & Emmanuel Saez (2013). "The Top 1% in International and Historical Perspective", *Journal of Economic Perspectives,* 27(3): 3-20.
For an excellent study on Germany, see Alexandra Spitz Oener, (2014, Winter), "From Sick Man of Europe to Economic Superstar", *Journal of Economic Perspective,* 28(1): 167-188.

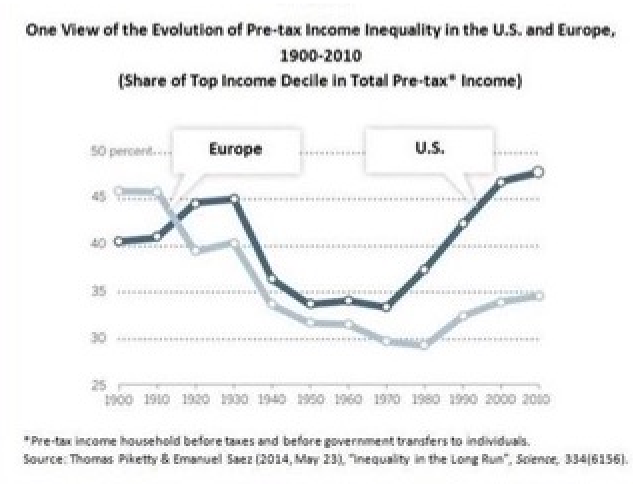
There is, in fact, wide agreement among economists that income inequality has grown over the last 30 years; there is less unanimity regarding how much, and sharp disagreement as to why this may have occurred.

The most discussed study of this topic has been a book translated from French and published in the U.S. in 2014: Thomas Piketty's *Capital in the 21st Century*. This volume has been acclaimed by many as one of the most influential books of the past decade, and is sure to play a major role in affecting debates over income distribution and economic policy worldwide.

This alone is reason enough to devote substantial attention to his study in this collection.

This study will doubtless have significant effects in shaping economic policy; but not always for the right reasons. Picketty's policy implications are stated quite explicitly: rectification of income inequalities will require a very high rate of income tax on top income recipients and wealth owners. The central finding is that inequalities in income and wealth in much of Europe, and certainly in the U.S., have sharply been increased since 1970. Moreover, (see Figure 2) Piketty believes that this trend--unless checked by high taxes on income and wealth--will continue into the future under capitalism. Specifically, he predicts a rise in capital's share in national income as the rates of economic growth slows in the 21st Century. He also assumes, based on his reading of the past that the return on capital (r) will remain relatively constant.

Under these conditions, the rise in capital's share in income will yield a growing gap between (r) and (g). [footnote] Over time this will result in greater income flowing into the hands of capital owners and will increase their wealth. Their steadily growing wealth, coupled with high returns on capital and slow overall economic growth, will exacerbate inequality in the distribution of wealth and income.
Within a year of publication in English (2015), Piketty had acknowledged that the gap between r and g (where r > g) explained little of the reasons for growing income inequality especially in the U.S. (See Robert Rosenkranz, "Piketty Corrects the Inequality Crowd", *Wall Street Journal* , March 8, 2015.



One View of the Evolution of Pre-tax Income Inequality in the U.S. and Europe, 1900-2010
(Share of Top Income Decile in Total Pre-tax* Income)

*Pre-tax income household before taxes and before government transfers to individuals.
Source: Thomas Piketty & Emanuel Saez (2014, May 23), "Inequality in the Long Run", *Science*, 334(6156).

The increasing gap initially forecast by Piketty, between (r) and (g) is not the only factor, according to Piketty, that has led to a growing concentration of wealth among the top decile since 1970 in the U.S. He cites another reason: sharply increased “supersalaries” for the “working rich”, primarily Chief Executive Officers (CEOs) of American publicly-owned firms.

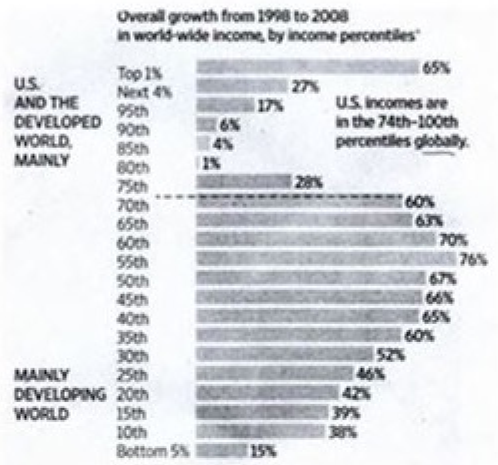
Piketty and Piketty and Saez (2014)[footnote] attribute very rapid growth of CEO salaries in large financial and non-financial firms to weakening governance in U.S. business firms. They argue that Boards of Directors or U.S. firms have become too timid to resist extravagant salary demands of CEOs. However, Piketty and Piketty and Saez offer only limited empirical support for this assertion. A detailed critique of the principal claims made by Piketty (and others may be found in the Appendix to this module).
Piketty & Saez (2014), p.842.

Sources of Rising Inequality: Developed Nations

Five likely causes of growing inequality in income distribution not cited prominently by Piketty include:

1. Globalization

   The growth of international trade and the growing interdependence between nations in goods and services markets as well as financial markets has clearly benefited emerging nations as a group. However, the recent pattern of trade that has emerged, i.e. rapidly rising exports from emerging nations to developed nations, has adversely affected industries in the U.S. and Europe-- especially those that are relatively labor intensive and use simpler technologies.


Globalization and Income Distribution: Rich and Emerging Nations

*Average income, adjusted for inflation and purchasing power, weighted by population.
Source: Branko Milanovic & Christoph Lakner (2014), World Bank Working Paper No. 6719, Washington, DC: World Bank.

The effects of globalization on income distribution have been extensively researched by the World Bank, among other institutions. One World Bank report indicates that globalization has increased income growth among lower and middle-income people in the developed nations of the West, while it has greatly benefited large numbers of people from the lowest deciles of the income distribution up to the 70th percentage especially in the mid-range of income distribution (see Figure 3).

Another study by Branko Milankovic arrives at essentially the same conclusion. He estimated changes in per capita real income between 1988 and 2008. He found that while the income of the worlds richest did rise sharply, the greatest beneficiaries of globalization worldwide were individuals in the middle of the income distribution, especially the emerging middle classes in such nations as China, India and Indonesia. Nevertheless, inequality has indeed been rising within nations in both emerging and developed nations.[footnote]

Branko Milankovic, (2013, May), “Global Income Inequality in Numbers: in history and now”, *Global Policy*, 10: 124-133.

2. Technological Change Itself

   Technological change in the past 20 years has tended to make some occupations in the U.S. and Europe redundant. At the same time, demand for highly-skilled workers has expanded rapidly. In the U.S. and Europe demand for low-skill labor has diminished, leading to higher unemployment of lower and middle-income workers. And unfortunately, the surest way to increase income inequality is to have a growing number of people with zero income (i.e. a growing number of unemployed).

   Technological change has surely been a factor in rising inequality. The benefits of technological change in recent years have not been evenly shared among work forces around the world. However, previous episodes of rapid technology change did not result in higher inequality in the U.S., at least. (Example: the electrification boom in 1920s in the U.S.).

3. Slowing Down in Growth of the Educational Attainment of the Young

   Whether inequality increases or not can depend on the result of an ongoing race between education and technology. Especially in the U.S., declining educational attainment, relative to technological change, has played a role. According to one authoritative source, there are fewer jobs available at good wages, and these have become increasingly unavailable for workers who lack advanced education. [footnote]
   See Claudia Goldin & Lawrence Katz, (2010), *The Race Between Education and Technology*, Cambridge, MA: Belkna Press of Harvard University Press.

   By the 1970s the U.S. was not only the richest nation on earth, it also had, by any measure, the most educated population. Income inequality in the U.S. then was little different from Europe. Only in the mid-70s did this begin to change. Productivity growth stalled in the U.S. Income inequality started growing slowly at first, then at a faster pace. By 2012, the gulf between the richest 1% persons and the rest of the

U.S. was the widest since 1928. The top 10% earned 19% of household incomes. And the top 10% captured 48% of total earnings in 2012. That the gap between the very rich and the poor has been widening is beyond dispute.

What might have been the roles of economic factors such as technology and declining quality of public education K-12 in contributing to growing inequality in the U.S? Two economists, Claudia Goldin and Lawrence Katz, both at Harvard, recently concluded that in the race between education and technology, education was winning the race for most of the 20th century, up to about 1975.[footnote] But since then, the rate of change in technology doubtless overtook the rate of improvement in education quality, specifically in K-12 public education, not in higher education. The slowdown in educational attainment is apparent by whatever standard employed. A commonly used standard is the results of the "gold standard" of international testing. Even as early as 1995, the Third International Math and Science Study (TIMSS) clearly indicated that the U.S. was far behind other nations in twelfth grade math and science. By 2012, the U.S. scores for math were only 481, far below South Korea (554) Finland (519) and Australia (504).[footnote] Clearly the U.S. no longer leads the world in the education of young adults. The results of the recent gap between technology and education in the U.S. is evident from the observed shortages of skilled workers not only in such industries as biotechnology and information technology, but in building construction, oil and gas exploration, and skilled electricians and plumbers.
Ibid.
OECD, *Programme for International Student Assessment (PISA)* 2012, (Paris, 2012).

The decline in educational quality in grades K-12 has not been due to lack of funding. The United States spends more public money on school-age children, in both absolute and per pupil terms, than any other nation. The outlay per pupil in 2013 was more than $13,000 per year in the U.S. This is one and a half times the average for all rich nations.[footnote] Moreover, teachers' salaries in the U.S. are on a par

with (or in excess of) such countries as Finland, the Czech Republic, Hungary, Australia, Britain and France. But, while the U.S. is 19th in an international efficiency index, Finland, the Czech Republic, Hungary and Australia are in the first ten in the index, and Britain and France are 11th and 12th.
“Choose Your Parents Wisely,” *The Economist*, July 26, 2014.

The former State Superintendent of Schools in New York, Marc Bernstein, notes that only 1% of the State’s teachers receive valuation of “ineffective”. But in the 2013-14 school year, more than half of students in grades 4-8 were not proficient in either reading or math. [footnote]
Marc F. Bernstein (2014, September 30), “Where All the Teachers are Above Average”, *Wall Street Journal*.

There are other indicators of inadequacies in K-12 public education. The former mayor of Los Angeles (and also a former organizer for the United Teachers of Los Angeles) maintains that more than half the young people attending community colleges need to retake high school classes because the education they received was not vigorous enough. [footnote] More generally, the number of all undergraduate students in U.S. colleges and universities taking at least one course rose from 1 million in 1999 to 2.7 million in 2011.
Antonio Villaraigosa (2010, July 21), “Why are Teachers Unions So Opposed to Change?” *Wall Street Journal*.

The decline in quality of the K-12 U.S. education system has also contributed to the recent fall in the competitiveness of the U.S. since the 1995 study cited by Goldin and Katz. In a list compiled by Professor Michael Porter and colleagues of the 30 nations with the highest index of international competitiveness,[footnote] the U.S. ranked 20th, whereas all the top seven nations in the competitiveness rankings have (by whatever measures) employed more effective systems of K-12 public education.[footnote]
See Michael Porter, Jan Rivkin (2012, March), "The Looming Challenge to U.S Competitiveness." *Harvard Business Review*, 90(3): 54–61.

Sweden, Switzerland, Finland, Netherlands, Denmark, Singapore and Norway. See Robert J. Barro & Jong-Wha Lee (2000, April), “International Data on Educational Assessment” CID Working Paper #42, Cambridge, MA: Harvard University.

At the same time as rapid technological change has sharply increased the demand for skilled workers, the decline in quality of graduates in the U.S. K-12 systems has clearly not allowed the supply of needed, well trained workers to increase as fast as the rate of technological change. In such circumstances, firms begin bidding up the wages of the most skilled workers. But the poorly trained and educated have been losing ground, and economic inequality has thereby worsened, especially for the poorest 10%.

On the other hand, educational outcomes in the great majority of emerging nations has been steadily, if unevenly, improving, especially since 1985. These improvements are especially evident for literacy rates. Adult literacy rates for developing nations as a whole rose sharply from 60% of the adult population (those 15 years and over in 1985) to 72% in low income nations and fully 90% in middle income emerging nations in 2007.[footnote]
For 1985, see World Bank, *Human Development Report 1991*, Washington, DC: World Bank. For 2007, *see World Bank World Development Indicators 2009*, Washington, DC: World Bank.

Female literacy rates were substantially lower than for males in 1985 (66%). By 2007, the female literacy rate rose to 76% of the male rate in the poorest nations and to 89% in middle income nations, reflecting gradually growing educational opportunities for women. An important reason for the climb in literacy rates in emerging nations was ongoing and widespread increase in years of schooling especially after 2003, with the single exception of war-torn Afghanistan [footnote]
World Development Report, 2013

However even there, levels of educational attainment in reading, mathematics and science have in general not risen as fast as gains in years of schooling and literacy, at least for the 25-odd emerging

nations for which data on these indicators are available. Exceptions include Chile, Colombia, Indonesia, and Tunisia.[footnote]
World Bank, *World Development Report 2013*, Figure 4-2.

Still, the recent economic record suggests that, contrary to the experience of the United States, deterioration in the effectiveness of primary and secondary education in emerging nations has not contributed to income inequality; rather, improving educational outcomes have most likely reduced income inequality.

4. Sociological Factors: The Decline of Families and the Fall in English Language Proficiency

Among the important sociological factors contributing to growth in income inequality in recent decades has been the decline in two-parent households and the sharp rise in the proportion of U.S. families headed by a single parent, usually a mother. In 1964 93% of births occurred in families headed by two parents, and only 7% of children were born to single mothers.[footnote] By 2012, the percentage of children born to single mothers increased to 29% for Caucasian families, 53% for Hispanics and 72% for African-Americans.
The Heritage Foundation, Special Report #117 on Poverty and Inequality, September 2012.

In families headed by married couples, only 7.5% had incomes below the 2012 poverty levels. But 34% of families headed by a single mother had incomes below the poverty level. Moreover 45% of children living only with their mother are in a household receiving food stamps, a clear mark of poverty.[footnote] Rapid growth in the number of these families has obvious effects on income distribution, as it significantly reduces the share of the lowest decile in income.
Jonathan Vespa, Jamie M. Lewis & Rose M. Kreider, (2013, August), “America’s Families and Living Arrangements: 2012”, U.S. Census Bureau. Retrieved from http://www.census.gov/prod/2013pubs/p20-570.pdf.

A growing lack of English language proficiency has also clearly contributed to the growth in inequality in the U.S. According to a 2013 study by the Washington-based think tank, the Brookings Institution,

nearly one tenth (9.3%) of working-age adults had limited English language proficiency. This is 2.5 times as many as in 1980.[footnote]
Most of the 19.2 million people with limited English in 2013 were Spanish speakers, mostly immigrants from Mexico, Honduras, El Salvador and other Latin American nations.
Metropolitan Policy Program, The Brookings Institution (2014, September 24), *Limited English Proficient Workers More Productive with Increased Investment in English*.

Clearly, lack of English proficiency does not preclude immigrant workers from finding jobs. But it does prevent them from holding higher-paying jobs. The share of the immigrant population in the U.S. labor force grew from 7% in 1980 to 16% in 2012. As long as limited English proficiency remains widespread among immigrants, income inequality rising from their source will likely increase over the coming years. Earlier in this module we observed that contrary to recent experience in the U.S., France and Britain, income inequality in emerging nations has generally moved toward less inequality. This has been particularly so in one region long noted for extremes in income distribution: Latin America. According to the Economic Commission for Latin America (ECLA), of the 18 countries there for which data exists, income inequality narrowed in 16 nations from 2002-08. [footnote]
United Nations, *Economic Commission for Latin America (ECLA)*, (Santiago, Chile, 2011).

In addition, Latin American poor have generally been doing much better since 1990 because of rapid recent economic growth. In that year, 48.4% of the region's population lived below national poverty lines (income insufficient to cover basic food needs). But by 2010, only 30.4% of the people in the region lived below their nation's respective poverty lines.[footnote]
Ibid.

We have seen that income distribution in most emerging nations generally has moved toward less inequality. However, some of the reasons for rising inequality in the U.S. and Europe since 1975 may eventually become significant in some emerging nations.

As noted earlier recent globalization has redounded to low and middle income households in lower and middle income nations (see Module 4, titled: "Globalization"). But these and other gains from globalization cannot go on forever. International trade has already expanded to 27% of world GDP even by 1992, well beyond what would have been expected only 25 years ago. So sooner or later the income distribution gains to emerging nations from international trade (see again Figure 3) will be largely exhausted.

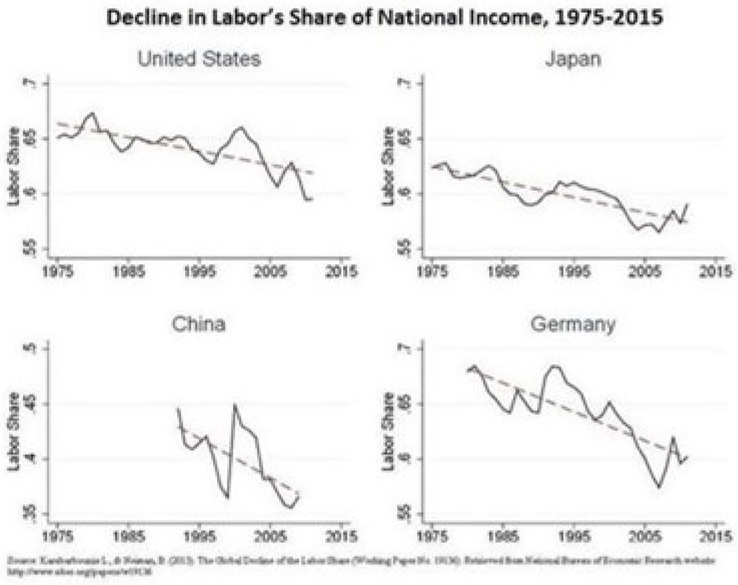
At the same time, technological advances may increasingly displace labor not only in rich but in poor nations (see the module titled: "21st Century Technology"). As discussed in the next section, both these factors combined – possible declining benefits from globalization and the shape of future technological change - could erode much of the gains in income equality in emerging nations over the coming years.

5. The Joint Effects of Globalization, Technological Change and the Evolution of Labor’s Share in National Income

A long tradition in economics has been the assumption that the share of national income received by labor was almost constant over time. Indeed this constancy was treated as a stylized “fact” from the late 1940s through the 1950s and even up until very recent years. However, this stylized fact no longer holds.

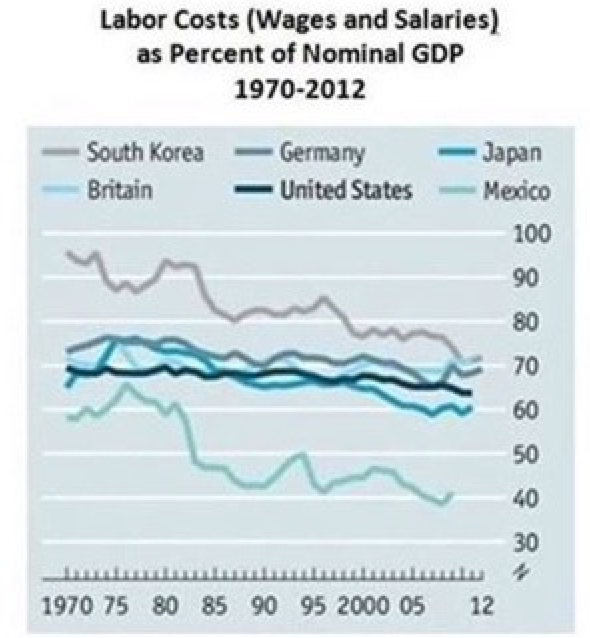
By 2014, it had become clear that an important indicator of increasing or decreasing income equality over time in any nation is the trend in the percentage share of labor wage and salary income (hereafter called labor’s share) in total national income. Historically the distribution of labor income has been much more equal than the distribution of capital income. Capital income tends strongly to accrue to those in higher income brackets. Therefore, a decline in labor’s share in national income over time will itself result in increasing inequality in the overall distribution of income (labor plus capital income). For many large, rich nations, and even a few emerging nations including China and Mexico, a clear pattern in labor’s share has emerged over the past

quarter century: the share of labor in national income has declined. In the U.S. and a few European nations, as well as in China, the decline in labor’s share has been especially notable and puzzling (see Figure 4). A major reason for the decline in labor’s share in the U.S. and several Western nations has been the steady decline in manufacturing employment as a share of total employment: the average decline in the U.S., Canada, France, Germany, Italy, Japan and the U.K. has been on the order of 14%.[footnote]
Martin Neal Baily & Barry P. Bosworth, (2014, Winter), “U.S. Manufacturing: Understanding Its Past and Its Potential Future”, *Journal of Economic Perspectives*, 28 (1): 3-26.



Decline in Labor’s Share of National Income, 1975-2015

Another relevant measure is labor’s share in GDP (labor costs, wage and salary income as a percent of GDP). Labor’s share in nominal GDP has been steadily declining since 1970 not only in the U.S., Germany, Japan and Britain, where it declined from around 70% to about 65%, but the decline has also been very sharp in both South Korea and Mexico (see Figure 5). The low Mexican share for labor is perplexing, until one realizes the very heavy importance of petroleum (and government returns from petroleum) in nominal GDP.



Labor Costs (Wages and Salaries)
as Percent of Nominal GDP
1970-2012

Source: Organization for Economic Organization and Development (Paris), as reported in The Economist "Labour Pains", (2013, September 2, p.77).

Some of the decline in labor's share in developed nations has been due to globalization (of trade, of financial markets, of investments), as exports of developing nations to the West have soared. One estimate, by researchers at the Federal Reserve Bank of San Francisco and the Federal Reserve Bank of New York, estimates that of the 4% decline in labor's share in the U.S. since 1990, 3.3 percentage points have been due to imports.

Technological factors have become increasingly important in explaining income inequality: digital displacement of labor, especially from robotics, has helped to reduce labor's share in national income in both developed and developing nations. Technological changes over the past 35 years have meant the cost of investment goods relative to consumption goods has fallen by one-quarter,[footnote] making labor-saving investment in capital goods more attractive.
Loukas Karabarbouras & Brent Neiman (2014)," The Global Decline of the Labor Share", *The Quarterly Journal of Economics*, 129(1): 61-103. Retrieved from http://qje.oxfordjournals.org.

Remedies for Income Inequality

Income inequality is not an issue to be treated lightly anywhere, as complex and serious questions are involved. The last 200 years of history suggest that no "quick fixes" are available. Rectification of income inequality takes time, if it is to be sustained.

In later modules dealing with fiscal and monetary policy, we discuss these remedies in some detail. However, at this point it is useful to summarize what has worked well (or not) in reducing income inequality. There are two basic approaches for attempting to reduce income and wealth inequality: "leveling up incomes" or "leveling down" of income distribution.

"Leveling up" relies on the expenditure side of the budget. This involves spending to foster human capital formation through outlays for education and public health (see the module entitled *Human Capital: Education, Public Health*), as well as direct government transfers to low income families, as in Brazil and Mexico in recent years.

Indeed, in a later module we consider evidence that Brazil's decade-old system of "conditional cash transfers" to low-income families with school age children was the most important factor in reducing income inequality there after 2009.

"Leveling down" involves primarily using the tax side of the budget, and has not worked well in rectifying income inequality over the long term.

Throughout most of the 20th Century, there was a pervasive belief worldwide in the efficacy of steeply progressive income tax rates in raising government revenues and in reducing income inequality. Neither expectation was realized. Consider the U.S. experience. From 1950-1963, the maximum rate of income tax was 91%. From 1964-1981, the maximum rate was reduced to 65%. The maximum rate dropped to 45% in 1982, to 35% in 1986, and has been in the 35-38% range since the year 2000 until 2014 when it again rose to 44% (including changes in 2013). What happened to Federal revenues as a percent of GDP over the period 1950-2008 as the rates declined? Federal taxes as a percentage of GDP have been roughly constant at about 21% from 1950-2008, in spite of highly varying rates over time. Reducing the steeply progressive rates of income tax after 1969 did not lead to a fall in the Federal tax share in GDP. And while income inequality has increased in U.S. in the past two decades, it also worsened in the early nineties, after the top tax rate increased from 35% to 40%. In this period, inequality increases were essentially traceable to technology change and globalization, and failure of public K-12 education rather than tax cuts.

In the U.S. and Europe, it is true some income redistribution has been accomplished by using the tax side of the government budget. In the U.S. in 2010, for example, the top 1% of the income distribution paid 38% of all federal taxes collected with maximum rates of income tax only half as high as in 1970. In 2013-14 the share of the top 1% in payment of income taxes in Britain was only 28%, considerably lower than in the U.S. However this proportion was only 11% in 1979, according to the Institute for Fiscal Studies.[footnote] Most developing countries before the eighties vainly tried to enforce progressive tax rates that topped out at 60-70%.[footnote] Taxes on the income rates reached 95% in Sweden in the 1980s. Steeply progressive tax rates have, in practice, been accompanied by preferential exemptions for favored industries and groups that have the usually unintended effect of primarily benefiting the wealthy. Very high tax rates also encourage widespread tax avoidance and evasion. The net result has been relatively little effect on income redistribution, but significantly negative effects on incentives to save, to work, to take risks, and on tax revenues themselves.
See "A Survey of the U.K. Tax System," *Institute for Fiscal Studies*, November 2014.
See Richard M. Bird & Eric M. Zolt, (2005), “Redistribution via Taxation: The Limited Role of the Personal Income Tax in Developing Countries”, *Tax Law Review*, 52.

Also, a major factor contributing to income inequality is having a lot of people with zero incomes (i.e. unemployed).

The country which has enjoyed the most success in reducing unemployment in Europe is Denmark. At the same time, Denmark has the lowest level of income inequality, not only in the European Union, but almost anywhere else.

Aside from Denmark, developed nations with low inequality are other Nordic countries such as Norway and Finland. Norway in 2012 had only a 3% rate of unemployment (1% in some regions). This compared to rates to well over 10% in most other European nations. Rates of youth unemployment in 2013 were especially high in Greece (40%), Italy (39%), and Spain 51%. And it should be noted that the Scandinavian countries have sharply reduced income tax rates over the past 25 years.

Why has recent employment growth been strong in Scandinavian countries? Largely because the Danes, the Finns, the Swedes and the other Nordic nations provide the best K-12 education in Europe. Their education systems yield graduates qualified for the jobs of the 21st century.

It is not because Denmark and Sweden spend the most money per student. That title belongs to the U.S., where per pupil spending is 1½ times that in Europe. It is because Nordic education is of very high quality for other reasons. It yields much higher literacy and numeracy levels than in France, England, and Italy. Nordic countries spend on education more efficiently, select teachers carefully, and train their teachers much more effectively - and they pay them well.

The Piketty Proposals in Perspective

Some economists, including Piketty remain convinced the best method for redistributing income from rich to poor is to sharply increase taxes on the wealthy, in order to “level down” the income distribution.

Income Tax Rate Increases

Arguments for sharp increases in maximum rates of income tax as well as enactment of a new global tax on capital were presented in 2014 by Thomas Piketty in a widely purchased book, Capital in the Twenty-First Century.

Piketty, it will be remembered, maintains that the degree of income and wealth inequality in the U.S. and Europe in 2008 is similar to that of a century ago. In fact, in Europe in 1900, the top 10% of households received 45% of all income. As it happens, the top 10% of households in the U.S. captured 45% of all income in 2010.

A main theme of Picketty's book is that a century ago, the high degree of income inequality was due to dividend rents and other returns to capital flowing differentially to the top 10%. He attributes much of recent inequalities to quite another set of factors.

As discussed in more detail in the Appendix to this module, Piketty's studies of the historical dynamics of wealth and income leads him to conclude that rates of personal income tax in, say the U.S. should be raised to 80% for incomes above $500,000. Indeed Piketty goes so far as to say that "the optimal top tax rate in developed countries is probably above 80%." [footnote] This compares to a top rate of tax of 38% in 2010 and 44% in 2014 in the U.S.
Thomas Piketty, *Capital in the 21st Century*, p. 512

Wealth Taxes

Piketty also proposes a worldwide wealth tax in order to increase progressive taxes in general and decrease wealth inequality in particular. [footnote] This progressive global tax on capital would involve a maximum tax rate of perhaps 10% on the largest fortunes. In the few nations that still impose a wealth tax; the maximum rate is 2.5% (Spain). This proposal appears after several decades wherein developed nations, with only a few exceptions, have abolished wealth taxes they had in place in the 1960s.
It is noteworthy that the wealthy developer Donald Trump proposed in 1999 a National Wealth Tax of 14.25% on the net wealth of people with assets in excess of U.S. $10 million.

The history of National Wealth taxes since 1965 strongly suggests that proposals for increases in worldwide wealth taxes are poorly conceived. In the U.S., the constitution prohibits any direct federal tax on asset holdings unless the revenues are divided up among the states on a per capita basis. Before 1985, thirteen member nations of the OECD taxed net wealth. [footnote]

Austria, Denmark, Canada, Finland, France, Germany, Iceland, Luxemburg, Netherlands, Norway, Spain, Sweden, and Switzerland.

As noted in the Appendix to this module, by 2012, eight of these nations abolished the net wealth tax. It remains in force only in France, Netherlands, Norway, Spain and Switzerland.[footnote] Few developing nations have adopted net wealth taxes; even fewer have collected significant revenues from the tax. Colombia featured a net wealth tax from 1935[footnote] to at least 2010, while India imposes a small net wealth tax levied at a 1% rate. The principal contribution of Piketty's book is his use of huge data sets to show how differences in rates of economic growth and the rate of return on capital have increased wealth inequality. For developed nations he notes that the historical rate of economic (g) growth has been approximately 3%. But he maintains the historical rate of return on capital (r) (note: non-human capital) has typically been between 4 and 6%.

See Michael Förster, Ana Llena-Nozal & Vahé Nafilyan (2014), "Trends in Top Incomes and their Taxation in OECD Countries", *OECD Social, Employment and Migration Working Papers*, No. 159, Paris, France: OECD Publishing.

Richard Musgrave & Malcolm Gillis (1971), *Fiscal Reform for Colombia*, Cambridge, MA: Harvard Law School, International Tax Program, pp.416-417.

The excess of the real rate of return on capital (r) over the real rate of growth (g), according to Piketty, increases income inequality over time. This is largely because the wealthy, being wealthy, are able to save more from differentially rising investment income. Under these circumstances, differences in wealth accumulation grow over time, and the share of the wealthy in total wealth grows.

This claim appears plausible, given that the share of labor income in national income has shrunk (see Figure 4), and the share of labor costs in total production has declined (see Figure 5).

Piketty's work has been roundly praised by some economists and roundly criticized by others. Much, but not all, of the controversy centers around questions about his data and his use of it. Economists such as Nobel Laureates Paul Krugman and Joseph Stiglitz have given the book enthusiastic praise.[footnote] On the other hand, such well-known and respected economists such as Martin Feldstein of Harvard and Chris Giles (economics editor of the London Financial Times) argue that Piketty's number "do not add up."[footnote] Giles goes as far as to dispute Piketty's claim that wealth inequality has risen since 1980, and argues that the "conclusions of Piketty's book do not appear to be backed by the book's own sources".[footnote] Critics such as Harvard's Greg Mankiw argue that Piketty's recommendations are motivated by ideology more than economics.[footnote]

See Paul Krugman, "Why We Are in a New Gilded Age (2014, May 8), " *The New York Review of Books.* Also see Edward Lazear (2014, May 5), "A Gifted Economist and the Ultimate Social Scientist," *Wall Street Journal*.

Martin Felstein (2014, May 14), "Piketty's Numbers Don't Add Up," *Wall Street Journal*.

"Picking Holes in Picketty," *The Economist*, May 31, 2014

"Bigger Than Marx," *The Economist*, May 3, 2014

Other critics such as Tyler Cowen of George Mason University maintain that Piketty's definition of capital is defective: he maintains that Piketty sees capital as a "growing homogeneous blob," and therefore fails to consider variations in the returns to wealth.[footnote] And of course, Piketty's definition of capital is also defective because it excludes human capital (K), which in many developed nations is more than 2/3 the total.

Tyler Cowen, (2014, May/June), "Capital Punishment: Why a Global Tax on Wealth Won't End Inequality", New York, NY: *Foreign Affairs*.

Nevertheless, some important lessons have already emerged from the controversy over Piketty's work.

There are perhaps four such lessons. First, published literature focused on the distribution of income or wealth is bound to be controversial, as it inevitably involves political as well as economic issues, not to mention disputes over data on wealth and income.

Second, it is apparent that while inequality has risen in many wealthy nations, global inequality has declined rather than risen since 1980, [footnote] as people in developing nations have been getting rich faster than rich people in rich nations (See Figure 3). Moreover, the percentage of the

world’s population living on less than $2.00 per day (adjusted for inflation) has halved since 1990.
Xavier Sala-i-Martin (2006), “World Distribution of Income”, *The Quarterly Journal of Economics*, 121(2): 351-397.

Third, the expenditure side of government budgets cannot be ignored in any serious discussion of income inequality. Piketty’s work ignores the redistributive effects of the spending side of government budgets. He does not take into account transfers and other benefits flowing from government expenditure programs, especially entitlement programs and direct budget transfers to the poor, such as the earned income credit in the U.S. and conditional cash transfers in Brazil and Mexico. We will see in later modules that these benefits can be very sizable at the lower end of the income scale.

Perhaps the most important factor in any serious discussion of capital in the 21st Century is what has been happening to the stock and quality of human capital. Significantly, Piketty’s definition of capital includes only what he calls non-human capital. Human capital as a component of total wealth is ignored, and he especially ignores the rapid accumulation of human capital worldwide in recent decades. We will see in the module on human capital that, certainly in the U.S. and other developed nations over the period 1975-2000, human capital was far more important than non-human capital in the nation’s growth.[footnote] We will also see in the next module just how important human capital has become worldwide, exceeding investment in physical capital in virtually all developing nations.
See Paul Beaudry & David Green (2002), “Changes in U.S. Wages 1976-2000”, NBER Working Paper No.8787.

Finally, prescriptions for large tax increases designed to improve income distribution cannot ignore the unsuccessful history of such measures. Piketty’s conclusions are that only sharp increases in top rates of tax on high income, high wealth individuals will improve equality in income and wealth. The history of economic policy suggests otherwise.

That history discussed earlier in this module suggests, for developing nations, these proposals would be even more dysfunctional than in rich nations, given the much lower capacity for tax enforcement and collection in the former.

A final reason Piketty type proposals will likely have little effect on curbing income and wealth inequality in developing nations in the 21st century is because a growing source of inequality in these nations has been the increasing worldwide displacement of labor in production, owing to technological revolutions now underway.

As we will see in a later module, the most efficacious way to reduce the threat of labor displacement in production is by expanded and improved public investment on the expenditure side of the government budget. Successful investment in new human capital bolsters employment in the face of rapid technological change. We have already noted that the best way to increase income inequality is to have a large number of people with zero income (i.e. unemployed).

Income Inequality and the Economic Literature

Income distribution issues involve profound philosophical questions, as well as vital economic and political issues.

The philosophical issues were well stated in the late 20th century exchanges between two extraordinary Harvard professors of philosophy: John Rawls and Robert Nozick.[footnote] Philosopher Rawls favored more income redistribution, but within limits. These limits, he argued, would be imposed by the effects of redistribution on economic incentives for the better off. Philosopher Nozick favored less income redistribution because of potential adverse economic effects of policies to reduce inequality.
John Rawls' publication of *A Theory of Justice* (1971), was hailed at the time as "the most important work in moral philosophy since the end of World War II," and is now regarded as "one of the primary texts in political philosophy." See also Robert Nozick, *Anarchy, State, and Utopia* (1977), published by Basic Books. [MG FIND SOURCE].

In any case, concerns over economic inequality are by no means new in economics. Adam Smith, widely recognized as an early effective advocate for capitalism, pronounced himself in 1776 in favor of measures, such as progressive taxes, to achieve some income redistribution in favor of the poor. To quote Smith from The Wealth of Nations, Chapter 2: “The rich should contribute to the public expense, not only in proportion to their revenue, but something more than that proportion.”

Among the most prominent 20th Century economists voicing concern over income inequality was Professor Henry C. Simons, widely recognized as one of the founders of the “Chicago School of Economics.”

While Simons was clearly market-oriented, his various books show that throughout his career, he was troubled about excess rewards to the wealthy in capitalist systems. He sought to “prevent capitalism from destroying itself by its own excesses.” [footnote]
See Henry Calvert Simons (1948), *Economic Policy for a Free Society*, Chicago, IL: University of Chicago Press.

Winston Churchill, the politician-historian who led the U.K. during World War II, also pronounced on inequality: “The inherent vice of capitalism is unequal sharing of blessing. The inherent virtue of socialism is the equal sharing of miseries.” [footnote]
Churchill speech, House of Commons, October 22, 1945.

Simons was not alone in believing that capitalism unchecked could worsen income distribution. This view was also voiced by other early members of the Chicago School, including Frank Knight, Jacob Viner, and, to a degree the Austrian Friedrich A. Von Hayek. Von Hayek came to Chicago in 1950, very late in his career. Other leading universities in Britain and the U.S. did not seek him out. But Von Hayek’s approach was clearly reflected in much of the Chicago School’s thinking almost from the beginning.

Of these four, only Von Hayek won the Nobel Prize (in 1974). Frank Knight, a true pioneer in the analysis of risk and uncertainty, died before the prize could be presented to him. Henry Simons might also have become a Nobel Laureate, but for his premature death by his own hand in 1947.

Knight, Von Hayek, Viner and Simons were all profoundly serious thinkers. They all cared deeply about the uses to which the discipline of economics were applied. All were critics of the results of unfettered laissez-faire capitalism, but all abhorred socialism and central planning. Knight believed that capitalism inevitably produced growing inequalities of income. Still he thought capitalism the only workable basis for economic organization. Hayek and Viner rarely pronounced on income inequality, but Henry Simons was clearly against it.

Here we devote more attention to Simons because his contributions are not fully recognized today. Henry Simons was by all accounts a marvelous mentor for several future Chicago Nobel Laureates in Economics such as Milton Freidman and J.M. Buchanan. He had a vision of a meritocratic America where economy and society rested on freedom and liberty above all, but with safeguards to prevent misuse of both economic and political power. He was a classical liberal, if not a full-fledged libertarian, who had little taste for “big government” but one who had very harsh words for reactionaries.

Economics students today are invariably surprised to learn that present at the creation of the Chicago School was one who favored:

1. Progressive income taxes
2. High rates of estate taxes (death taxes)
3. Vigorous enforcement of antitrust laws, to prevent abuses of monopoly and oligopoly powers

Simons advocated some degree of progressive income taxes and high death duties because he believed a well-functioning capitalistic system would generate, besides prosperity for the great masses, significant income inequalities. This, he expected, would occur precisely because of the power of the system to deliver the goods: to furnish the products and the services people needed and wanted efficiently and cheaply. In the process, some entrepreneurs and capitalists would receive, by luck or good timing or by entrepreneurial cunning, unusually high rates of return on their investments in capital and in labor skills. As these high returns flow largely from the operations of a national market made possible by institutions established by a free society, Simons saw little reason to allow the most fortunate to keep all of their winnings. He did not view reasonable levels of progressive taxes and high inheritance taxes as threats to capitalism. Rather, he thought use of

these tools would in the end help nourish the individual freedoms upon which capitalism depended for its success. In his view, these safeguards would limit the scope for severe inequality and the concentration of economic power over time. Thus, capitalism could be prevented from destroying itself from its own successes. In 21st century America, Henry Simons would argue very strongly against the repeal of death taxes, on grounds that such levies not only make economic outcomes fairer, they would be perceived to do so, thereby curbing the scope for social conflict over economic outcomes. Lest you think Simons belonged on the left wing of the political continuum, consider that he thought that a 10 percent share of Federal taxes in GNP was just about right (versus over 22 percent today). [footnote]
Simons' advocacy of strong antitrust policies flowed also from his fear of the threat to capitalism from excessive concentration of economic power. Like so many of his contemporaries in (and outside) the Chicago School, Simons was a steadfast proponent of competition. Therefore he was also an ardent foe of monopolistic practices, because private sector monopoly invariably yields inefficiency and usually inequity both in rich and poor nations. He was also quite even-handed in his disdain for restrictions to competition. He opposed monopoly power by labor as well as by business, viewing labor unions as disposed to such anti-competitive practices as featherbedding.

Whatever older views might have been, income inequality is not a problem that can be ignored anywhere. Here is the good news. Many nations have achieved some degree of income redistribution both through the tax side and the expenditure side of the federal budget. But like the Nordic nations since about 1980, they have increasingly achieved this by relying not on the tax side but the expenditure side of the budget, by channeling government spending into growth facilitating human capital formation as programs of direct budget transfers to poorer households. These lessons were widely learned; notably, from 1984 through 2000, nearly 50 nations - including Indonesia, Ghana, Mexico, Estonia, Lithonia, and Poland - enacted tax reforms involving much simplified, more enforceable taxes imposed at lower, flatter rates, thereby enhancing their capacity for meeting the needs of poorer groups through programs of effective government spending. As one result, by 2013 all nations had lower corporate tax rates than the U.S., where a 35% rate is virtually double the world average.

Rarely mentioned in discussions about inequality in the U.S. is the very large and increasing share of federal taxes paid by the wealthy. In 1979, the top 1% of the income distribution paid only 18% of total income taxes. By 2003, the share paid by the top 1% had climbed to nearly 35%. According to the Tax Foundation, by 2010 the top 1% earned 19% of gross national income, and paid 38% of all federal taxes. And, by 2013, according to the Economist (September 20, 2014) this group paid 46% of total taxes largely because of the U.S. Earned Income Tax Credit (EITC), which results in millions of families receiving checks from the Internal Revenue Service instead of paying income taxes. The top 10% receives 45% of national income and pays 59% of taxes. The bottom 50% pays just 3% of taxes, while 40% of U.S. households pay no income taxes at all, partly because of their income tax exemptions.

Increasingly in tax reform, developing and developed countries have turned to one particular type of low-rate, simplified indirect tax. This tax is the value added tax (VAT), a superior type of tax both in raising revenues and avoiding adverse economic effect. Since 1965, nearly 160 nations including Denmark, Sweden, Chile and nearly 20 African nations have adopted this highly feasible tax, including 21 in Sub-Saharan Africa and over a dozen in Latin America.

An Overlooked Lesson on Redistribution and Taxes

It is important to understand that countries can impose high rates of personal income tax and still prosper, if they can collect high rates of tax. The empirical record shows that over the years countries can indeed use high tax rates and collect the revenues (with little evasion) but only if the rates are not punitive and the taxes are used to provide services valued by taxpayers, as in Denmark, Sweden, and Norway in the late 20th and early 21st Century. To illustrate, in the late 1990s, government spending in Sweden was 68% of GDP. Even after Sweden reduced substantially income and wealth taxes after 2004, government spending supported by taxes was still 52% of GDP in 2012. But, the quality and coverage of government-

provided public services, especially in pre-university education and health care is quite high relative to say, the U.S. The Swedish tax burden (taxes as a percent of GDP) remains high. Clearly taxes are used to provide public services valued by taxpayers, and taxpayers are not reluctant to pay taxes. [footnote]
"The eight-year Itch", *The Economist*, September 13, 2014.

And as long ago as the 18th Century, Scots and English rich elites willingly paid higher taxes than was the case in the 17th century. Why? Because they perceived that they received substantial government services for the pounds they paid in taxes.[footnote]
Arthur Herman (2001), *How the Scots Invented the Modern World*, New York, NY: Three Rivers Press, p.58-59.

APPENDIX

Piketty and Income Inequality: A Closer Look

There are at least three factors that reduce the credibility of Piketty's results. First, the results pertain to the evolution of pre-tax income over time. That is, the author does not take into account the effects of existing taxes, direct transfers from government to individuals (such as welfare payments or social security payments). The use of pre-tax income as the measure of inequality is difficult to understand in a book intended to be policy relevant, particularly since the data on post-tax, post-transfer income (at least in the U.S.) is readily available. This is a significant issue given the degree of progressivity of effective rates in the U.S. federal tax and the pro-poor effects of government transfer payments.

Consider federal taxes. [link] shows that average tax rates paid by the top decile of the income distribution are nearly 12 times that of the lowest quintile. In an era of high, and probably growing, pre-tax inequality of income, it should not be surprising that the share of the one percent most highly paid Americans has grown sharply: in 1979 the top 1% paid 18% of total income tax. By 2013, the share of the top 1% had grown to 46%, while 40% of households paid no income tax at all. [footnote] These figures

suggest that, at the very least, the tax system has had some moderating effects in reducing post-tax income inequality.
Economist, September 20, 2014, p.13

Table 1
Average Federal Tax Rates, by Before Income Tax Group, 2013 Projected
(Under 2013 Tax Rules)

	2013	**Multiple of Top 1% to Lowest Quintil**
Quintiles		
Lowest Quintile	2.9%	11.5
Second Quintile	8.0%	4.2
Middle Quintile	12.3%	2.7
Fourth Quintile	16.4%	2.0
Highest Quintile	25.5%	1.3
Top Percentile		
Top Decile*	23.8%	1.4

Table 1 **Average Federal Tax Rates, by Before Income Tax Group, 2013 Projected** **(Under 2013 Tax Rules)**		
Top 1%	33.3%	

*Average of 90th to 99th percentiles

Source: Congressional Budget Office, “The Distribution of Household Income and Federal Taxes, 2011”. Washington, DC, 2014, p.16.

A comprehensive report from the Congressional Budget Office (CBO) in 2014 presents an exhaustive account of the effects of taxes and transfers in the United States from 1980 to 2010, closely corresponding to the period 1970-2010, a period of increasing income inequality reported by Piketty.

This study concludes that, when taxes and transfers are taken into account, income inequality has increased, but not as sharply as one would conclude from the Piketty results According to the CBO study, the Gini Coefficient in the U.S. increased from 0.48 to 0.59 from 1980-2010, if taxes and transfers are omitted in the definition of income.

Taking into account taxes and transfers, the Gini increased over the same period, but from 0.37 to 0.44, an increase of 19%, compared to an increase of 23% when taxes and transfers are not included in income. This study helps confirm that income inequality in the U.S. has increased since 1980, but not by as much as would be indicated in studies utilizing before-tax income, including that of Piketty.

The CBO study is but one of the recent publications that counsels caution in interpretation of reports of sharply increasing income inequality in the U.S. One highly reported, award winning study published in 2012 argues convincingly that because studies such as those of Piketty, and Piketty and Saez, exclude the effects of taxes, transfers, and in-kind benefits to middle-income earners, they also overstate the growth of income inequality since 1980.[footnote]

Richard V. Burkhauser, Jeff Larrimore & Kosali I. Simon (2012, March), "A Second Opinion on the Economic Health of the American Middle Class", *National Tax Journal*, 65(1): 7-32.

This study clearly shows that while the pre-tax, pre-transfer income series used by Piketty (and collaborators) may be a useful starting point for measuring how American workers are compensated in the labor market, the policy implications of Piketty's results are rather limited. Indeed the Piketty results even understate the pre-tax returns to work, because they ignore the sharp increases in middle income workers income coming from sharply growing values of employer-provided health insurance.

The critical issue is, however, what has been happening to the overall economic resources available to individuals.[footnote] This can be determined only by examining income measures that reflect after-tax, after-transfer income as well as the value of employer health insurance, so as to reflect the total financial resources available to individuals.
Burkhauser, Larrimore & Kosali, p.19.

The Burkhauser, Larrimore and Korali study does show that income inequality in the U.S. increased, but not for the same reasons or by nearly as much as indicated by Piketty. Rather they show that income inequality increased not just because the rich got richer, the poor got poorer and the middle class stagnated. Instead, "the rich got richest quintile at a faster rate than the middle and lower quintiles." [footnote] Growth was substantial in all quintiles once researchers account for the effects of government tax and transfer policy and the shift in composition from wages to employer provided health insurance.
Burkhauser, Larrimore & Kosali, p.19.

The study by Burkhauser et al. concludes that, by this income measure, while income growth for the top 10 percent in the U.S. was indeed rapid, at 56%, income growth over the period 1979-2007 was significant for all quintiles (see [link]).

Table 2
Mean Income Growth by Income Quintile, 1979-2007

	Household Size Adjusted, Post-tax, Post-transfer + Health Insurance
Bottom Quintile	26.4%
Second Quintile	25.0%
Middle Quintile	36.9%
Fourth Quintile	40.4%
Top Quintile	56.0%

Source: Burkhauser et al.

And while the Gini Coefficient on this measure did increase over the period, the increase was moderate, from 0.330 to 0.362, much less than in studies using the most restrictive definitions of income. In any case, the Piketty results are not as relevant for public policy as would first appear.

Nevertheless, Piketty proposes radical changes in public policy to rectify the income inequalities he reports for the U.S. and Europe. The most striking of these proposals pertain to taxation. Piketty proposes a very high rate of income tax on 80% or more on top incomes,[footnote] together with enactment of progressive taxes on net wealth that reach 10% on the largest fortunes. These proposals reflect a degree of ignorance of the history both of income and net wealth taxes. Worldwide experience with both taxes has clearly shown that tax rates of this magnitude are unenforceably high.
Piketty, *Capital in the 21st Century*, p.512.

The Piketty Proposals for enactment of very high rates of income and wealth taxes overlook the large public finance literature on the positive relationships between income tax rates and tax evasion and avoidance. One of the latest of these contributions shows that attempts to reduce budget deficits with corporate tax rate increases tends to be offset by an increase in activities in the shadow economy.[footnote]
Denvil Duncan & Klara S. Peter, (2014, June), "Switching on the Lights: Do Higher Income Taxes Push Economic Activity into the Shade?" *National Tax Journal*, 67(2): 321-350. See also the list of over 40 references on this topic in this article.

Indeed, in the decades since 1980, dozens of nations, including the U.S., much of Europe, and many emerging nations have sharply reduced top rates of personal and corporate income taxes[footnote] in recognition of both economic and administrative difficulties in attempting to enforce sharply progressive rates of tax.[footnote]
Malcolm Gillis, Dwight H. Perkins, Michael Roemer & Donald R. Snodgrass (5th Edition, 2006). *Economics of Development*, New York, NY: W.W. Norton & Co.
Notably, the Socialist Government of Piketty's home country, France, abandoned as fruitless in 2014 an attempt to impose a 75% rate of tax on top incomes (above 1 million Euros).

The decline in rates was worldwide. In a sample of 189 nations from 1981 and 2005, the top statutory marginal rate of the personal income tax declined from 62% to 36%. In addition, the top statutory rate for corporate income taxes declined from 44.6% to 30.5%.

Piketty's proposals for a very high rate of net wealth tax are even more unrealistic than that for income tax rates, and fly in the face of several decades of experience with this tax.[footnote]
The basic version of Piketty's wealth tax would impose a tax rate of 1 percent on net worth of $1.3 million and $6.5 million and 2 percent on net worth above $6.5 million. Piketty contemplates additional tax brackets, including a bracket of 0.5 percent starting at about $260,000.

Prior to the 1980s, several European nations as well as Canada, and Colombia imposed net wealth taxes. But, especially since 1990, most

European nations have abandoned this type of tax. Austria and Denmark repealed the tax in 1995, and Germany did so in 1977. Luxemburg[footnote] and Finland abolished it in 2006, and Sweden did the same in 2007.[footnote] Colombia[footnote] used a net wealth tax from 1937 to 1992, when it was eliminated. During a reverse crisis, the tax was reintroduced in 2003, but imposed at a rate of only 0.3% (compared to the Piketty proposal). [footnote]

Michael Forster, Ana Llena-Nozal, & Vahe Nafilyan (2014), "Trends in Top Incomes and their Taxation in OECD Countries", OECD Working Paper No. 159.

Wikipedia (Retrieved from: http://www.en.wikipedia.org/wiki/Wealth_tax, on 9-23-2014).

Adrian Rodriguez, "Net Worth Tax in Colombia: Past and Future". In progress 2015 pending publication.

See supra note 57.

The Colombian Government proposed a restructuring of the wealth tax in 2014, a proposal reported here to illustrate real world rate structures for the tax. A rate of 0.2% applies to the first US$1 million in wealth. The applicable rate for the next US$500,000 is 0.35, with a maximum marginal rate of 1.5%, so that the average rate on net worth exceeding US$2.5 million is less than 1%.

Rates for all countries are included in [link]. There it can be seen that in no country does the tax rate exceed 2.5%, and that is in Spain, a nation with notoriously poor tax administration. But in no case do rates approach those proposed by Piketty, and for good reason.

Notably, in the country Piketty cites as the one where income inequality increased the most (the U.S.), the constitution prohibits the use of federal net wealth taxes.

Table 3
Net Wealth Tax Rates (2014)
Europe, Latin America and India

Country	**Rate Structure**
France	Progressive rate from 0 to 1.8% of net assets
Spain	Progressive rate from 0.2% to 2.5% of net assets above €700,000
Iceland	(Tax repealed in 2006, reintroduced in 2014 for 4 years only). Rate is 1.5% of net assets exceed ISK for married couples
India	Wealth tax of 1% on wealth exceeding 30 lakhs
Columbia (proposed 2014)	Wealth tax with average rate on wealth exceeding US$2.5 of 1.00%
Netherlands	Rate of 1.2% on assets in excess of €21,139
Norway	National and Municipal net wealth taxes of 1% on net assets exceeding NOK1 million

Source: Wikipedia Ibid

A second problem in the Piketty approach is his assumption concerning the elasticity of substitution between capital and labor. An increasing gap between (r) and (g), as assumed by Piketty, is possible only if the elasticity of substitution (s) is greater than unity. The elasticity of substitution is an important determinant of how a change in the price of capital or of labor will affect the share of total income received by capital or labor: it measures the extent to which the capital-labor ratio changes when the ratio of the price of capital to labor changes. This elasticity is defined as:

$$S = -\left(\frac{\Delta X_K/X_L}{X_K/X_L} \div \frac{\Delta\left(\frac{P_K}{P_L}\right)}{P_K/P_L}\right.$$

When X_K is the quantity of capital employed in production, X_L the quantity of labor employed, and P_K and P_L are the prices of labor and capital respectively.

If $S<1$ then when the price of labor increases relative to that of capital, then capital's share in total income will decrease. If $S=1$ capital's share will be constant. If, as maintained by Piketty $S>1$, then capital's share in total income will increase over time.

The computed value of the elasticity of substitution (S) may be equal to, greater than or less than unity. If $S>1$, then (as maintained by Piketty) the share of capital income will increase, thereby increasing income inequality. However, if $S<1$ there will be diminishing, not increasing returns to capital.

Thus, the share of capital income will decrease as the ratio of capital to labor rises, contrary to Piketty.[footnote]
Even as late as the seventies, economists tended to believe that the elasticity of substitution was about one: Studies over the first three quarters of the 20th century consistent found that labor shares in total income was roughly constant, and ranged between 70% to 80% of total real income. But these studies ignored, among other things the effects of technological change. See Ed Mansfield, *Microeconomics* (3rd edition, New York, NY: Norton 1970).

Piketty assumes that (S) rises over time, so that (r)>(9) rises as well, and therefore income inequality rises. The preponderance of empirical evidence shows otherwise:[footnote] the gross elasticity of substitution in 26 of 31 studies on the topic shows a value of less than one, typically between 0.40 and 0.60,[footnote] values wholly inconsistent with a growing share for capital, as claimed by Piketty.
See Robert Chirinko (2008, June), "σ: The Long and Short of It", *Journal of Macroeconomics*, 30(20): 671.
Matthew Rognlie (2014, June 15), "A Note on Piketty and Diminishing Returns to Capital", Department of Economics, MIT.

A second reason offered by Piketty for growing inequality of income is sharply increased compensation (“supersalaries”) for the working rich. However, the author presents scant quantitative evidence to support this claim.

In past centuries, the prime reason for inequality in income distribution was the pronounced inequality of wealth: the growth on assets of the rich and powerful, especially the emergence of high remuneration of the summit of the wage scale,[footnote] in particular top managers of large firms, or the “working rich.”
Piketty, *Capital in the 21st Century*.

The growing assets of this group, according to Piketty (land, bond holdings, ownership of enterprises) generated high returns for them, while the working poor and middle income families possessed little wealth.

Not prominently mentioned among the “working rich” are stars of show business (from movies to music to T.V.) and top professional athletes, who also have reaped unusually large compensation since about 1985.[footnote] The view that supersalaries have been significant in driving inequality is shared by economists such as Paul Krugman and Robert Solow.[footnote]
Paul Krugman (2014, September 30), “Taking a True Picture of our Invisible Rich, *Houston Chronicle*.
Robert Solow, June Lecture, Lexington, MA. Solow calls the phenomenon the growth of “supersalaries.”

“Supersalaries” of the rich have indeed grown rapidly in the past 20 years. Total CEO salaries (and stock options and other benefits) in 2012 were $52 billion for the Fortune 500 largest firms.[footnote] This amounts to less than one-half of one percent (0.4%) of total personal income in the U.S. in 2012, hardly large enough to constitute a major cause of rising inequality.
For the 500 largest firms in the U.S. (the Fortune 500 firms), average salary of CEOs was $8.5 million in 2010. By 2012, average salaries in the 500 largest firms were $10.5 million; of the $10.5 million average CEO “salary” in the largest 500 firms, $3.5 million was salary and bonuses, $3.2 million from exercising vested stocks (stock options) and $3.8 million “other” (*Forbes Magazine*). The highest paid was the CEO of McKesson, who

earned $6.3 million in salary plus $112.0 million from exercising stock options.

However, not all very highly paid executives are employed by the largest Fortune 500 firms. Consider Hedge Funds of the largest 500 firms the 391st largest is Blackstone, which is not wholly a hedge fund. In any case, the claim has been made that the top 25 hedge fund managers received compensation, on average, of almost $1 billion each. If this is true, their earnings of this group would have totaled almost $25 billion. Thus the total of salaries paid to CEOs of the 500 largest firms and that paid to the top hedge fund managers would be $77 billion, or about 0.6% of personal income.

If the total compensation of professional athletes (football, basketball, soccer) and all motion picture, T.V. and music stars[footnote] were as much as CEO compensation for the Fortune 500 firms, then all the "supersalaries" for these CEOs, plus the top 25 hedge fund managers would amount of $129 billion or about 0.09% of personal income.
Paul Krugman, "Why We're in a New Gilded Age", (retrieved from http://www.nybooks.com, May 8, 2014)

And if the total 2012 payrolls in all professional athletics (football, baseball, basketball, soccer etc.) and all motion picture, T.V. and music stars[footnote] was also as much as 0.4% of personal income then these "supersalaries," together with CEO salaries and hedge fund rewards, would have accounted for less than 1% of total personal income.
Top linebackers and defensive ends in the U.S. National Football League (not to mention quarterbacks) routinely earn between $20 and $40 million annually. Television stars in popular sitcoms earn up to $40 million or more per year. And in 2013 two country music stars each made in excess of $33 million. The total payroll for the 10XXXX According to the *Wall Street Journal* (September 31, 2014) major league baseball teams was $105 million. Fifteen of the players on these teams had contracts greater than $100 million.

Piketty, Piketty and Saez,[footnote] Krugman and others attribute the rapid growth of CEO salaries in large firms to governance issues in U.S. business firms. They argue that Boards of Directors are too timid to resist

extravagant CEO salary demands.[footnote] Piketty and others make little or no mention of skyrocketing compensation of athletes, and entertainment stars. Supersalaries and superearnings for professional athletes have been largely caused by the rapid growth in television payment especially in professional football, basketball and baseball.
Piketty & Saez, 2001.
In Piketty's book, Capital in the 21st Century, he states that the reason that highly paid corporate CEOs pay themselves so handsomely is because they can, given weak governance, especially by Corporate Boards.

A 2014 study by economists from the University of Cambridge and the Hong Kong University for Science and Technology questions the general claim that CEOs are grossly overpaid.

Their study of the "pay premium" in compensation of American senior corporate objectives covered 149 firms from 1991-2008. The measure used in the study was the changes in firms' share value when the CEO or other very senior executives die suddenly. The authors posited that when an overpaid CEO dies, investors will expect his successor's pay fall to erase the "pay premium" and will therefore bid up the company's shares. [footnote] By their measure, 42% of the senior executives were not overpaid. Indeed, those with the highest compensation were found to have boosted their company's stock market value by at least the amount of the pay premium.[footnote]
See "The Final Reckoning," Economist, September 6, 2014.
There are unquestionably egregious examples of inflated CEO salaries. A case in point was the CEO of Cheniere Energy, based in Texas. The CEO's executive compensation in 2013 was $142 million, including stock grants and salary. This was the highest CEO salary in 2013. This was 46 times the salary paid to peer CEOs, about 5 times that of CEO pay for energy giant Exxon. It is notable that shareholders voted 53% to 47% against Cheniere, but the vote was non-binding. It is also interesting to note that the company's shares increased from $3.09 in January 2010 to 84.46 on September 18, the day the salary was announced. This amounted to an increase of 27 fold over 4 years. Source: "Cheniere Shareholders Say No on Pay" (2014, September 19), *Houston Chronicle*.

While “supersalaries” may have contributed marginally to a widening income gap in the U.S., this source of income inequality was even less evident in Europe, partly because of governmental and private pressures to restrain tendencies toward escalating salaries for CEOs. Nor is there, to date, any plausible evidence suggesting that supersalaries have been significant in emerging nations in increasing inequality.

PERSPECTIVES ON THE ROLE OF CAPITAL IN DEVELOPMENT: PHYSICAL CAPITAL, HUMAN CAPITAL, INTANGIBLE CAPITAL, AND NATURAL CAPITAL

Adam Smith published what was to become the “handbook” for capitalism in 1776: The Wealth of Nations. Since then, economists have continued to ask how we measure the wealth of nations.

For several decades, economists and policy-makers (and just about everyone else) have used GDP (Gross Domestic Product) as a measure of a nation’s wealth. But GDP is a number generated by national income accounting exercises, and is really a measure of annual income not the stock of a nation’s wealth.

Much better options to measure national wealth have been recently developed including one in 2012 by Partha Dasqupta at Cambridge University. His work focuses on national wealth in 20 nations: 17 developed nations and 3 emerging nations. This type of study will eventually be extended to more than 100 emerging nations.

Dasgupta identifies 3 types of assets that constitute wealth. Together, these 3 are called “comprehensive wealth”, or “inclusive wealth”. They are:

1. Physical capital
2. Human capital
3. Natural capital

However, Dasgupta does not attempt to measure intangible capital (wealth) assets discussed in a later module. These include wealth implicit in institutions prevailing in a given nation.

Definitions:

Physical Capital: Machinery, computers, and physical infrastructure such as roads, harbors, and bridges. Physical capital is often called “produced” capital. China increased its physical capital by an almost incredible 540% from 1980 to 2008.

Human Capital: Education and skills imbedded in a nation's people. Human capital formation also includes longer and better lives made possible by public health programs, disease prevention, and treatment. We will soon see that the stock of human capital is not the primary determinant of technological change. In several nations the size of the human capital stock is much greater than the stock of physical capital.

Natural Capital: Nature’s endowment of fossil fuels, minerals, fresh water fisheries and forests. Forests include pristine forests, improved forests, as well as forests degraded by humans.

[link] depicts a balance-sheet measure of wealth for some of the nations included in Dasgupta’s study. As measured, the stock of wealth in the U.S. in 2003 was nearly $118 trillion (in 2000 prices). The emerging nations of Brazil and India had wealth of $7.4 trillion and $6.2 trillion, respectively.

[link] shows comprehensive wealth per capita. The U.S. had the highest accumulation of comprehensive wealth (see [link]). But total or comprehensive wealth per person was the highest in Japan. It is also evident that for developed countries included in [link], wealth from human capital far exceeds wealth from all other sources. But in Saudi Arabia and Venezuela, natural capital dominates.

Country	**2003 (trillion of U.S.$)**	**Growth Rates 1990-2008 %**
U.S.	117.8	0.7
Japan	55.1	0.9
China	20.0	2.1

Country	**2003** **(trillion of U.S.$)**	**Growth Rates 1990-2008 %**
Germany	19.5	1.8
Britain	13.4	0.9
France	13.0	1.4
Canada	11.1	0.4
Brazil	7.4	0.9
India	6.2	0.9
Australia	6.1	0.1

Trillions of Dollars, Total Wealth (inclusive wealth) Selected Nations 2008, and Rates of Growth 1990-2008 (%)Source: Partha Dasgupta, *U.N. Report*, 2012 (cited in the *Economist*, June 30, 2012). Note: In the U.N. Report figures of Table 1, human capital was calculated based on a country's average years of schooling, the wages of workers and workers retirement ages.

Country	**Human K**	**Natural K**	**Physical K**	**Total K**
Japan	300	1	115	416
U.S.	290	10	90	390

Country	**Human K**	**Natural K**	**Physical K**	**Total K**
Canada	175	99	40	314
Norway	200	40	80	320
Saudi Arabia	70	105	20	200
Venezuela	50	45	10	105

Per Capita: The Relative Importance of Physical, Natural and Human Capital in Total Wealth 2008 U.S.$ ThousandsSource: Partha Dasgupta, *U.N. Report*, 2012 (cited in the *Economist*, June 30, 2012).

The relative shares of human capital in total wealth come as a surprise to many (see [link]).

In Japan, per capita human capital in 2000 was 72%. For the U.S., the relative share of human capital was 74%. The figures for Canada and Norway (both relatively rich in natural resources) was 79% and 62.5.

Per capita total wealth in resource-rich Saudi Arabia and Venezuela was substantially less than in Japan, the U.S., Canada and Norway. And the share of human capital in both nations is also much lower: 3.5% for Saudi Arabia and 48% in Venezuela.

By the time you finish this collection, we will have covered three types of tangible capital plus intangible capital. Let us first examine the growth record worldwide from 1975-2000, and then the years from 2000-2008 (see [link]).

Briefly, for 1975-2000 we had:

World Economic Growth	2.8%
Low Income Nations	3.4%

So, growth was pretty good from 1975-2000. If we were to believe all the naysayers in the 90s and the early part of this century, who argued that the fruits of the liberalization of economies became sour, we would expect that growth would have declined. As the data shows, however, those fruits did not turn sour in the first years of the new century.

If growth rates were good in 1975-2000, they were even better from 2000-2008, before the economic meltdown of 2008-2010.

	Growth Rate (% per year)		
	Population	**GDP per Capita**	**Total GDP**
World	1.2	1.8	3.0
High income	0.7	1.5	2.3
High income non-OECD	1.5	3.0	4.5
High income OECD	0.6	1.5	2.1
Middle income	1.2	4.8	5.9
Low income	2.1	3.4	5.5

	Growth Rate (% per year)		
	Population	**GDP per Capita**	**Total GDP**
Least developed countries: UN classification	2.4	3.8	6.2
Heavily indebted poor countries (HIPC)	2.6	2.2	4.8
East Asia & Pacific	0.8	7.8	8.7
Euro area	0.5	1.4	2.0
Europe & Central Asia	0.1	5.7	5.8
Latin America & Caribbean	1.3	2.3	3.6
Middle East & North Africa	1.9	2.6	4.5
South Asia	1.6	5.0	6.6
Sub-Saharan Africa	2.5	2.3	4.8

World Economic Growth 2000-2008Source: *World Bank* database

	Population 2008	**Population**	**GDP per Capita**	**Total GDP***

	Population 2008	**Population**	**GDP per Capita**	**Total GDP***
China	1,324.7	0.6	9.3	9.9
India	1,140.0	1.5	5.5	7.0
United States	304.1	1.0	1.3	2.3
Indonesia	227.3	1.3	3.8	5.1
Brazil	192.0	1.2	2.4	3.6
Pakistan	166.1	2.3	2.4	4.7
Bangladesh	160.0	1.6	4.1	5.7
Nigeria	151.2	2.4	3.6	6.0
Russian Federation	142.0	0.3	7.3	6.9
Japan	127.7	0.1	1.4	1.5
Total or Average	3,935.0	1.2	4.1	5.3
Excluding China	2,610.3	1.2	3.5	4.7
World	6,697.3	1.2	1.8	3.0

World Economic Growth in 10 Most Populous Countries 2000-2008Source: *World Bank* database
* = column 2 + column 3

Overall growth of total GDP from 2000-2008 was a hefty 4.7% if we include China (3.0% excluding China).

So, in the early years of the new century, the pace of economic growth not only accelerated, but spread more widely among nations. This occurred after the first years of globalization, when barriers to international trade as well as income tax rates were declining worldwide. In the process, many emerging nations were steadily moving toward convergence with North America, Europe and Japan. Consider: that at economic growth rates from 2000 to 2009 that allowed per capita income to grow at 3.2% per year faster than rich ones. At these rates, only about 40 years would be required for emerging nations to "catch up" with the U.S.

However, this process received a hard jolt in 2008-2010 with the international economic meltdown that led to the worldwide great recession. During the recession, per capita rates of growth in emerging nations tumbled from 2009-2013. They grew only 1.1% faster than the U.S. At that rate, 123 years would be required to catch up to the U.S.

A return to rates of growth prevailing in 2000-2008 will require very substantial investment of capital.[footnote]
Economist, September 13, 2014.

We first examine the role of physical capital (manufactured capital) in the growth process. We will later examine some estimates of the relative role played by physical capital formation.

But for a moment, just note that the following typical components of physical capital contribute to growth (all Physical capital):

Corporate Investment	50.0%
Non-corporate Investment	17.5%

Housing Investment	17.5%
Government Investment	12.5%
Other Investment	3.5%

More on this later.

We will see that in previous models of economic growth economic theorists were long preoccupied with physical capital. In fact, human capital had no place at all in the models, which were widely used and respected even 25 years ago.

The role of human capital in development was long neglected. No more. But there is now a danger that in stressing the role of investment in human capital, we may obscure the importance of investment in physical capital, in assets such as factories and equipment in the private and public sectors.

Consider roads.

In the U.S., how many days were required to cross the country by road in 1920? Answer: 62 (because of the primitive road network). By 1993, the U.S. had invested an additional $425 billion (in 2006 dollars) in the interstate system - 42,000 miles of new roads crisscrossed the nation. The result: costs in U.S. industry fell sharply by 20 cents for each $1 invested in the interstate system. And, the interstate highway system had a huge impact on productivity, and U.S. competitive advantage. The inexpensiveness of road transport in the U.S. is still unmatched anywhere.

The interstate highway system was born in the first term of Dwight Eisenhower.

In the late 1950s, 1/3 of annual U.S. production increase was due to the interstate highway system.

In the 1950s 1/4 of annual U.S. production increase was due to the highway system.

In the 1980s, 7% of annual U.S. production increase was due to the highway system.

Consider the Chilean highway system in Patagonia in 1967 and then in 2007, 40 years later. In 1967, it was impossible to go by car to Patagonia (one could only go from Santiago to Puerto Montt). Major investment in roads there has been strongly beneficial to economic growth.

Investment in physical capital in road infrastructure was also important in Portuguese growth in recent years (1980-98). An empirical study in the International Economic Journal (September 2011) found that government investment in road infrastructure in Portugal had 4 positive effects:

1. In increasing private investment (lowering transport costs)
2. In creating new jobs
3. In promoting long term growth in all five of Portugal's regions
4. In positively impacting the government's budget.
   How positively? New tax revenue generated by the road projects exceeded the costs of road investments by the government.

Interesting corollary — Portugal (along with Greece and Spain) was in a bad way in 2014 – high fiscal deficits and debt owed to other European nations. However, if Portugal sharply decreased spending on roads to but the deficit, the result would have been decreasing long-term growth.

Also, you will see that technological advances everywhere, and especially in emerging nations, require huge amounts of investment, both in terms of human and physical capital. Change, when it occurs, now comes fairly swiftly, due to technological innovation made possible by investment in human capital.

Traditionally, the World Bank and the U.N. have divided the world's countries into 3 categories:

- Developed
- Developing
- Under Developed (definition now obsolete?)

With the kind of rapid technological change now underway, combined with globalization and increasing inter-connectedness of world markets, these categories will be obsolete by 2025.

In 2025, nations will not be categorized as developed or developing, but as smart, smarter and smartest.

With advances in biotech, nanotech and infotech, and with increasing degrees of competition flowing from globalization, most people will have to change not just jobs, but careers 2-3 times in a lifetime.

Only the well-educated, highly adaptable will thrive. Keep focused on India. Today, one South Korean produces as much as 20 Indians (and have the same GDP even though South Korea has 1/20 the number of people). But India has a large, growing reservoir of smartness. Combine this with democracy plus a higher education system still superior to China = Great Prospects, provided India finally begins to rectify a very large deficit in one type of physical capital – infrastructure, including roads, ports, harbors.

Models Of Economic Growth

Increasingly, nations seek to increase not merely economic growth, but sustainable economic growth over time. We postpone until later discussion of issues on sustainable growth, such as air and water pollution, sensible use of natural capital (energy, forests, water and fisheries) and climate change.

In the past six decades economic growth in emerging nations has been substantial but not always sustainable. However, it is undeniable that such economic growth as has occurred in emerging nations has had very significant beneficial effects on the world's poorest people.

Growth has sharply reduced the incidence of immiseration and deprivation. The international definition of poverty is an income per person of less than U.S.$1.25 per day. The share of the world's population living on less than $1.25/day has dropped from 30% in 2000 to 10% in 2014. Growth has helped to drastically increase life expectancy. A century ago, life

expectancy at birth worldwide was but 30 years. By 2014, life expectancy had reached 70 years, and in developed nations such as Sweden and Italy, 82 years.[footnote] Infant mortality has also fallen very sharply especially in emerging nations, from China to Peru. In 1990, an infant mortality rate (under 5 years) in Ethiopia was 200 deaths, Bangladesh 149, Cambodia 120, Peru 88 and China 50. In all these nations' rates in infant mortality in 2002 were at least 60% below 1990.
"The Headwinds Return,"*Economist*, September 13, 2014.

Finally, an average year of schooling in emerging nations has tripled from two to seven years over the period 1950-2010.

Economic growth has yielded very substantial increases in income per person, especially in the period 2000-2009, when growth per capita income was 4.5 percentage points above that of rich nations.[footnote] Continuation of this high rate of growth would allow per capita income per person in emerging nations to equal average U.S. income per capita by 2045.
See Human Morality Database, 2014

However, these high growth rates fell sharply after the onset of the world recession beginning in late 2008: average GDP per capita in emerging nations (excluding China) grew at 1.1% faster than in the U.S.[footnote] At that rate, income per capita in emerging economies would not catch up to rich-world levels until the year 2170. And if 2014 growth projections from the IMF are to be believed, continued low growth at this rate in emerging nations (excluding China) would be only 0.39 percentage points greater than in the U.S. The implications are dire: this would mean that 3 more centuries would be required for per capita income to catch up to the West.
Including rapidly growing China would mean that emerging nations could reach rich-world levels by about 2064 (*Economist*, September 13, 2014, p.29).

Economic Models

The quest for economic growth has given rise, over the past 50 years, to a quest for models of economic growth that might reveal pathways for pursuing policies for increasing per capita income over time in emerging nations.

We first review classical approaches, then later theories and models of growth.

NOTE: M.G. Include Solow Model???

Productivity Curves And Growth

Understanding of economic growth has evolved considerably since over the past 300 years. From 1800 to about 1960 discussions were dominated by the classical theory of growth. (Adam Smith, David Ricardo and Thomas Malthus).

This theory stipulated that any real GDP growth is bound to be temporary: human living standards will never improve.

What reasons lie behind such a profoundly pessimistic view? To begin with, we need to understand the concept of subsistence per capita GDP. This is income just enough to live on. In the early classical theories there was a supposed iron law linking population growth to increases and decreases in per capita GDP. Whenever something happens to make per-capita GDP rise above subsistence, nutrition and health improves, then births rise and population grows. Population growth, in turn, would then bring GDP/capital back to subsistence. In fact, this was the historical experience in the period 500 c. - 1700 C.E. as we have seen. A temporary rise in per capita GDP (living standard) was seen as truly temporary.

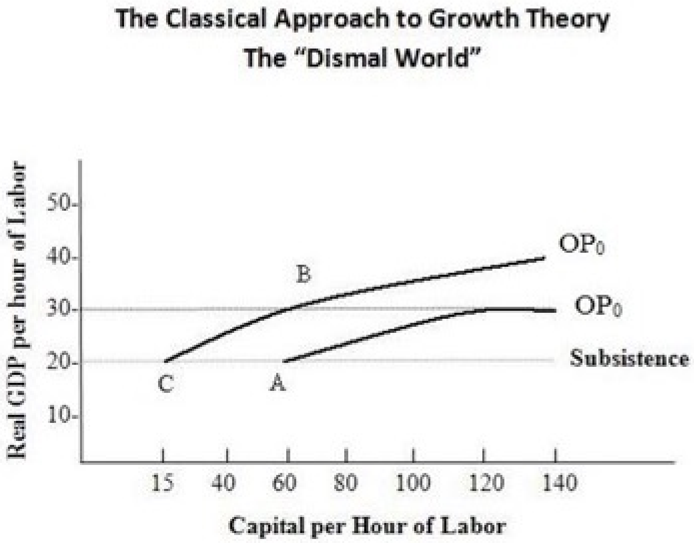
So, classical “growth” theory was the no-exit story; i.e. things will never get better. An example:

First consider subsistence GDP per capita: the minimum required for people to live out their life expectancy. Assume subsistence GDP = $20 per hour of labor work (see Figure 1). The vertical axis shows real GDP per hour of labor (in dollars of year 2000). The horizontal axis shows the amount of capital used per hour of labor.

Now, according to the example, if real GDP per hour of labor falls below the $20 subsistence level ($20 per hour of labor), population falls. If real GDP per hour of labor rises above $20, the population rises.

In Figure 1, the, economy begins at point A with real GDP/hour at $20 and the amount of capital per hour of labor at $60.

At this point, it is important to note that the outcome of the classical theory depends on diminishing returns to capital. In other words, more labor applied to a fixed amount of capital must mean successively smaller increments to output. Also, in classical theory, all capital is just physical capital. There is no knowledge capital, no human capital, and no intangible capital.



The Classical Approach to Growth Theory
The "Dismal World"

Michael Parkin (2005), "Economics", Pearson Education, Inc.

To illustrate classical growth theory, we begin with an original productivity curve OP_0 - showing how real GDP/hour changes as the amount of capital per labor hour changes, given the state of technology.

So, with given technology and productivity curve OP0 the economy is at point "A" (subsistence).

Consider now what happens if there is a technological advance? (Steam engines, cotton gin, etc.). This yields a new productivity curve OP1 and higher productivity per labor hour.

Now, economy moves to point "B." But, here real GDP hours exceed subsistence. The result is that population grows, as Malthus theorized.

With more labor being applied to constant capital per hour, real GDP/hour falls back to $20. At point C, because of the Law of Diminishing Returns, GDP/hour drops back to subsistence level. You can do no better. Forget about bettering the human condition. Of course, the classical theory is now seen as only a highly deficient explanation of growth.

Economists views of determinants of growth have, thankfully, changed greatly in the last century.

Growth theories of the 20th and 21st century hold that real GDP/hour can grow and that growth can persist for long periods. The human condition can be improved.

As we shall see, newer growth theories hold that pursuit of economic incentives (profit) and innovation can lead to sustained growth. In the new growth theory, human capital (knowledge capital) becomes important.

Knowledge, of course, is a form of capital that is not subject to the law of diminishing returns. (If I use knowledge on the internet, is there any less for available for you)?

Recall that diminishing returns in production arise when one resource is fixed (say capital), and the amount of another resource is unchanged.

But, we now recognize that an innovation and expansion in the stock of knowledge makes both labor and physical capital (machines) more productive. So, an increase in knowledge capital does not bring diminishing returns.

Now, Early 20th Century Models of Growth

Growth and development are complex processes. One way we try to come to grips with this complexity is to build models. Model building is veryimportant andvaluable in our efforts to understand the growth process. It is important not to fall into the trap of believing that what was once good for now wealthy countries in the 19th and 20th centuries is always good for poorer nations in the 21st century. For one thing there are vast differences in initial conditions that faced now-wealthy nations and the initial condition facing most developing nations.

Example:

- The U.S., Canada and Australia faced very favorable initial conditions in 18th and 19th century. There was an abundance of land, fairly temperate climates, and good endowments of natural resources. But the initial conditions facing most (not all) poor countries were much less favorable and many had to cope with the damages left by centuries of colonialism. In the great majority of cases, colonialism was especially damaging to institutions, to soils, and to systems of governance, to name a few.

So, it is evident that "one size never fits all." Even as between poorer countries as a group, there are just too many differences in initial conditions and subsequent conditions. However, early 20th century models of economic growth were based on the idea that one size fits all

Let us also consider generalizations about development. The first generalization is that it is very difficult to make defensible generalizations about economic development. We are, after all, talking about 160-170 odd nations that are conventionally called emerging, or less developed, and 40 countries that are called nearly developed.

In fact, there are as many differences between individual developing countries as there are differences between developing countries and developed ones. This is not surprising given the vast differences between developing countries. These include differences in:

- Cultures
- Natural resource endowment

- Climate (*500* years ago tropical regions were richer than in northern regions)
- Colonial Past (much of sub-Sahara Africa’s lower per capita GDP stem from its colonial heritage)
- Ideological differences
- Leadership differences

Growth Models- Old and New

Let us examine some 20th century models in Growth and Development. Only 30 years ago most courses on economics and development spent at least a month focused on models purporting to capture the essence of growth and development.

In this collection we will spend only a few pages on them, mostly as a place-marker in the history of economic thought.

First was the Harrod-Domar Model: a widely taught model in the first half of the 1950s. Harrod-Domar[footnote] was concerned exclusively with the rule of physical capital accumulation in economic growth. This is an extremely simple model, formulated by desk-bound professors and taught by desk-bound professors to other desk-bound economists.
This model was developed by Roy Harrod and Evsey Domar in the 1950s. The model is single-mindedly focused on investment in physical capital (the concept of human capital was not formal until the sixties).

This model led to shallow thinking and more importantly, to some misapplied policies. The author clearly remembers the Vice President of the World Bank, Hollis Chenery, in 1975 lecturing to the Indonesian Ministers of Finance and Planning on the singular importance of physical capital accumulation.

One result of the dominance of this approach was a widespread tendency to think of the structure of the Harrod-Domar model as a reflection of the real world. Many then viewed parameters of Harrod-Domar as actually pertaining to world experience. A list of disastrous policies by aid donors

and recipient governments attributed to thinking fostered by misuse of variants of the Harrod-Domar model, presented below:[footnote]
A more detailed presentation of the Harrod-Domar model may be found in Dwight Perkins, Stephen Radelet and David Lindauer , *Economics of Development*, (6th edition 2006, Chapter 11).

(1)

- $y = \frac{K}{V}$
- K = Physical capital stock, not considering Human Capital
- Y = Annual Output (Income)
- V = a constant, the capital output ratio. Where
-
    - $V = \frac{K}{Y}$
    - Note that Harrod-Domar assumes that output is a linear function of capital and capital only.

The capital output ratio was thought to be range from 3-6 in poor countries.

-V=5 means that it takes an initial $25 million investment in capital to produce, annually, $5 million worth of product.

A high V means capital intensive production.

A low V indicates labor intensive production.

Note: V can be high in very poor countries if capital is underpriced, and therefore used inefficiently, as it often has been owing to interest rate controls; especially controls that keep interest rates below the rate of inflation.

From this simple formulation, the economics profession moved on to the ICOR, or the Incremental Capital Output Ratio, where

$(V = \frac{k}{y})$

.

- The ICOR reflects the productivity of additional capital that is the amount of new capital required to get an increment of output
- Armed with an ICOR, economists determined a growth relationship, showing changes in annual output resulting from changes in capital investment.

(2)

- $\Delta Y = \frac{\Delta K}{v}$

- Dividing through both sides of (2) by income (Y) yields a growth rate g.

(3)

- $g = \frac{\Delta Y}{Y} = \frac{\Delta K}{YV}$

- This is the Harrod-Domar Model which focuses on growth investment, not net investment. Thus it ignores depreciation of capital.

The Harrod-Domar model was not a bad way to begin organizing economic thinking about development. But the undue focus on capital in the model required economists and policymakers, in rich and poor countries, to channel almost all attention on the need for additional physical capital to make economies grow faster. The weaknesses of the Harrod-Domar approach stem from this problem.

It is worth noting that the 1960s and 1970s version of the Harrod-Domar model ended up being the basis of the strongest arguments for foreign aid and central planning. In fact, the Harrod-Domar model was widely used as a basis for central economic planning in many nations, especially India before 1982. All the planners needed to do was:

1. calculate ICORS for all sectors of the economy;
2. allocate capital to each sector according to plan priorities; and
3. sit back and watch the economy grow at rates determined by the increment in capital in each sector.

Clearly, if the key for growth was to sharply increase investment, then the next issue was: where to find the ital in the model required economists and policymakers, in rich and poor countries, to channel almost all attention to the need for additional savings to finance investment.

- Recall, in the simplest formulation in national income accounts:
- Y= C+ I +G and
- $I = I_g+I_p + I_F$
- and Expost, I must equal S.
- Investment must be financed by savings, so we have:
- $S = S_p + S_G + S_F$
- [Note= $S_G = T-G_C$]

INVESTMENT

I_G = Government Investment I_P = Private Investment I_F = Foreign Investment

SAVINGS

S_P = Private Domestic S_G= Government S_F = Foreign

CONSUMPTION

Includes private consumption and government consumption

If, as in many poor nations, especially in the fifties, S_p is near zero (because of both low incomes and poor tax collection) then under these conditions how does a nation finance investment. The usual answer in the sixties and seventies was to rely on foreign savings (S_F).

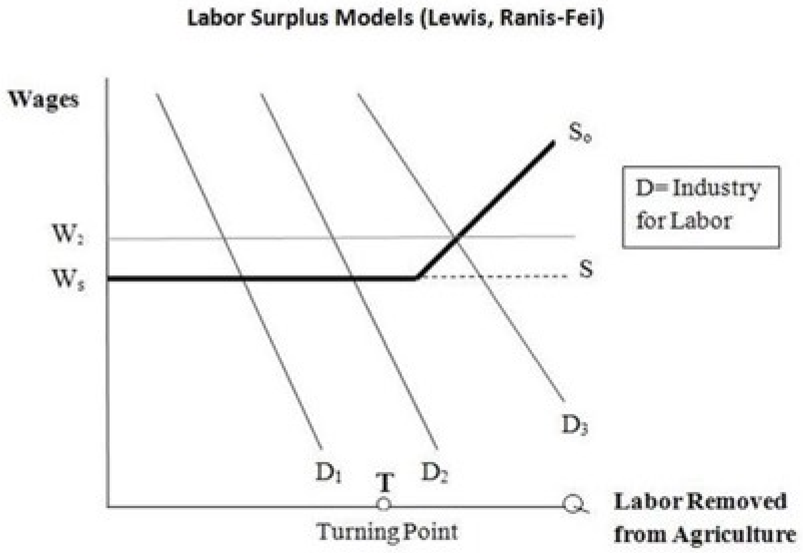
And as we see in later modules, foreign savings is split into two parts:

- S_{Fo} = Official Foreign Savings, and
- S_{Fp} = Foreign Direct Private Savings.

Another simple model of economic growth and development that strongly affected thinking was the 2-sector Ranis-Fei Model. This was a concept of economic development based on unlimited supplies of labor. In the 1960s and 1970s, this model also enjoyed very wide currency among economist and policy-makers especially in Africa and India.

To be sure, in the 1960s the model was most appropriate to poor nations with large agricultural sectors (where agriculture was greater than 50% of GDP). Note in 2008 U.S. agriculture was 2% of GDP. The Ranis-Fei approach builds on a 1955 contribution by W. Arthur Lewis, which in turn was based on the work of classical economist David Ricardo in 1820. So the intellectual lineage of Ranis Fei was Ricardo and Lewis.

The principal labor surplus models can be depicted as in Figure 2. Real wages remain constant and labor supply is constant until enough labor is removed from agriculture by growing demand for labor (from D_1, to D_2 to D_3). A turning point is ultimately reached, at T in Figure 2.


Labor Surplus Models (Lewis, Ranis-Fei)

In Figure 2,

- W_s= Subsistence wage
- S= Labor supply at subsistence wage
- Turning point: where surplus labor in agriculture exhausted marginal product of labor and the wage rate begin to rise, both in rural and urban areas.
- D_1= Period 1 demand for labor by industry
- S_o= Labor supply now more inelastic (after turning point is crossed)

- D_2= Demand by industry for labor in period 2
- D_3= Demand by industry for labor in period 3

To recapitulate, Arthur Lewis presented a two-sector model which depicted economic development with unlimited supplies of labor, or at least continuing labor surpluses. This assumes continued rapid growth in population. Gustav Ranis and John Fei at Yale extended Lewis' model in a book: Development of the Labor Surplus Economy. They focused upon the relationship between industry and agriculture in conditions of labor surplus with exogenously determined subsistence wages. Both the Lewis and Ranis-Fei models postulated a perfectly elastic supply (horizontal) curve for labor in agriculture, up to the point where labor's marginal product in agriculture rises above the subsistence wage.

The implications of these 1950s and 60s vintage models were taken quite seriously in their day. How useful might they be for the 21st century say for China before 2008?

The Ranis-Fei model predicted rather dire consequences for real wages both in industry and agriculture. Note that the model assumes population rises steadily forever. However, when population growth slows, drawing labor out of agriculture will eventually drive up real wages in both agriculture and industry. Ranis-Fei type models were somewhat helpful in certain conditions. And, in China in the 1960s and 70s, population was still growing notably, and most arable land was already being cultivated. Adding growing amounts of labor to fixed supply of land-leads to diminishing return and thus falling marginal product (MP). In China, labors MP was very low. Under these conditions increases in population and increases in labor force in agriculture added little to total agricultural output, just as predicted in the Lewis and Ranis-Fei constructs. Urban wages in China—read industrial wages—did rise a bit in the early 1950s. But then urban labor experienced limited gains for two decades until 1977. In those two decades, tens of millions of agricultural workers attempted to migrate to the cities, even in the presence of stagnation in industrial wages. However, they were prevented from doing so by legal constraints on rural to urban migration, (especially by the rise of internal passports). With 2% per annum population growth until the mid-70s, labor surpluses in the Chinese country continued to grow so that the agricultural labor force then accounted for a staggering 71% of total employment, compared to the U.S., where about 4% of labor force worked in agriculture in the late 20th century. At the same time, there was (somewhat surprisingly) a small shift in the rural-urban terms of trade in favor of agriculture. (Terms of trade: Prices of urban produced product in terms of rural produced products). China clearly was in a labor surplus situation.

All this began to change in China in the late 1970s. Authorities sought to attack the labor surplus by a nationwide, draconian effort to bring down the birth rate.

By 1980, Chinese population expansion had slowed to only 1.2 % per year, and stayed below 1.5 % for the next two decades. During that time rapid growth in urban industrial and services sectors was absorbing more than 10 million workers annually. As a result, the workforce in Chinese agriculture began to decline steadily after 1991, to less than 50% by 1997. In that year, for the very first time in Chinese history, farmers made up less than half of all Chinese workers. And by 2011 rapid urbanization meant that there were more people in urban than rural areas.

In the process, growing poles of urban prosperity arose, not only in Beijing and Shanghai, but throughout the Pearl River delta and in Chunking, WuHan and other interior cities. Even by 2004, Chinese urban wages were above $.80 per hour, slightly above those for Indonesia and about ¾ that of India.

But by 2008, the Chinese labor market had changed radically. According to some, China’s previous labor supply surplus had been used up. The growth in labor has slowed dramatically, due to the one-child per family policy. From 1995-2005 there was 1.3% annual compound growth in labor supply. But, owing to the one-child per family policy, the 2005-2015 growth in labor supply halved (0.7), and by 2018 China may experience a zero percent growth in labor supply.

So, has China already reached the “Lewis” turning point? Maybe not. Some believe the turning point will come only in 2020.

In any case, China will not be able to fuel its growth on cheap labor much longer. In fact the country has been steadily switching strategies — accepting large amounts of foreign investment, investing more heavily in technology and, as we will see, somewhat relaxing the one-child per family policy. China’s average annual growth in total factor productivity is at 4%, the highest in world, followed by India (2.8%). The U.S. rate is 1%, while Russia's is 1/4 of 1%.

We mentioned rapidly growing urban prosperity. What has been happening to living standards in Chinese agriculture?

Chinese who have remained in agriculture experienced much lower rates of income growth than in urban areas. This is especially true for women who have confronted increasing ambiguities regarding land tenure security.

The number of landless women in China has been trending upward. By 2002 nearly one in five married women lacked any land allocation at all. [footnote] Daughters, to put it mildly, are not highly valued in rural China. In many very poor villages that lacking clinics or medicines, local populations find ways to buy ultrasound machines. Why? To determine the sex of the children in the womb.
Denise Hare, Li Yang, Daniel Englander (2007) Land management in rural China and its gender implications, Feminist Economics, 13:3-4, 35-61, DOI:10.1080/13545700701445298

The nature of decollectivation in agriculture begun in the early 80s has been partly responsible for growing numbers of landless women. Prior to the 1980s there were 15-year contracts on land, with provision for adjustment every five years or so, this gave way the 1980s to much longer contract durations of 30 years. Daughters find it very difficult to stake a claim to land, even when they remain in the same village after marriage. And a daughter who moves to a new village because of marriage does not increase land allocations for the husband’s family. As a result, women’s net rights to land have declined.

There are, by the way, other institutional determinants of women’s loss of agricultural land. These include inheritance practices and customs, the nature of divorce and widowhood and, as in most of the world, a tendency of males to discount women’s work. It turns out that in much of rural China few adult single women are landless. Landlessness seems largely concentrated among married women below age 40. There also is a strong relationship between household income and the decision-making authority of women: women in low-income settings have considerably less decision-making authority.

As the reader proceeds through this collection, he or she will not be surprised to learn that what is good for raising rural incomes is generally also good for addressing the issue of women’s landlessness and reducing morbidity especially for curbing the growth of AIDS.

Capital Formation, Human Capital and International Trade

International trade, human capital formation, and the role of women turn out to be interlinked.

There are significant long-run implications for Chinese agriculture—and by extension for landlessness—in China’s recent accession to the World Trade Organization in 2009. Adherence to the WTO should yield beneficial results for such Chinese labor-intensive industries as textiles and apparel. Results for agriculture and rural households are somewhat indeterminate. The possibility of more export opportunities for certain agricultural products might be counter-balanced by stiffer competition from such agricultural imports as food grains and cotton.

What might globalized WTO accession mean to rural women in China? In emerging nations in the 1970s and 90s job expansion in textiles and apparel, first in Malaysia and then later in lower income Indonesia and Bangladesh, tended to favor women relative to men. It should be noted that clothing production requires some significant levels of educational attainment. For example, plants in Bangladesh and other major apparel-exporting nations usually require at least a junior high school level of education. Thus, overall improvement for women from the WTO is not likely to occur unless there are improvements in women’s access to better education, credit and marketing structures, given that substantial numbers of women will remain in agriculture after WTO accession.

Note again the inter-relationship between the lesson about human capital and the lesson about trade.

Again, nothing in economics is independent from anything else in economics. Economics is complicated only because things are so inter-dependent.

That is also what makes “good” economics so interesting.

INVESTMENT IN HUMAN CAPITAL: EDUCATION AND HEALTH

Several earlier modules have mentioned the important role of human capital in economic growth and development. We now focus more directly on investment in human capital, including any and all investments in improving human capabilities. Chief among these are:

- Primary education, secondary education, university education and research,
- Business training and research programs, including “on-the-job” training,
- Vocational education, and
- Learning by doing.

Without doubt, the first category of human capital investment is the most consequential. We will devote most attention to it.

But the role of the other categories should not be ignored. The category “learning by doing” is interesting in and of itself. In Nobel Laureate Kenneth Arrow’s study of airframe manufacturing in World War II, increased amounts of labor and capital did not fully explain the tremendous productivity of U.S. aircraft plants: the U.S. made more B-24 bombers than all the aircraft produced by Japan. Why?

The effects of learning by doing.

Aristotle defined “learning by doing” 2000 years ago.

To quote:

"For the things we have to learn before we can do them we learn by doing them."

At this point, it is helpful to note that throughout this module, numerous examples of human capital investment and its implications are given. One of the sources cited most often is a long series of studies from the National Bureau of Economic Research (NBER), a nationwide network of economic researchers with headquarters in Cambridge, Massachusetts. The NBER traces its origins back to the late 1920s.

Human Capital: Theory and Applications

Economic thinkers from David Ricardo to Karl Marx and J.M. Keynes viewed capital merely as physical assets owned by capitalistic firms. This view prevailed in economics until well into the 1950s. Then, the work of, first, Theodore Schultz and subsequently the 1964 publication of the book Human Capital by Gary Becker[footnote] changed forever how economists and policymakers view capital. Both were Nobel Laureates in Economics; both spent most of their careers at the University of Chicago.
For a good retrospective on Gary Becker, see “Gary Becker (1930-2014)”, *Science*, June 13, 2014, 344(6189):1233.

This revolution in economic thinking began with an article by the father of the human capital concept: Theodore Schultz of the University of Chicago. His 1961 contribution, “Investment in Human Capital,” was a true landmark in the Annals of Economics.[footnote] He asserted that the definition of capital needed to be further expanded to include forms of human improvement. To quote:
Theodore Schultz, “Investment in Human Capital,” *The American Economic Review* 50:1 (March 1961).

"Although it is obvious that people acquire useful skills and knowledge, it is not obvious that these skills and knowledge are a form of capital, that this capital is in substantial part a product of deliberate investment, that it has grown in Western societies at a much faster rate than conventional (nonhuman) capital, and that its growth may well be the most distinctive feature of the economic system."

Schultz was led to think of the idea of human capital from his experiences in post-war Germany (1946-48) where he examined the effects of allied carpet-bombing of Nazi-Germany.[footnote] The Allies believed carpet-bombing of Dresden, Frankfurt and other German cities would bring the German war machine to its knees quickly. But that did not happen. Large

land forces from the U.S. and U.S.S.R. were needed in 1944-45 to defeat the Nazis.
c.f. Kurt Vonnegut’s novel, *Slaughterhouse Five*, which depicts in striking terms the effects of Allied bombing on the City of Dresden in Germany.

Consider this quote from Schultz:

"Another aspect of the same basic question is the rapid postwar recovery of countries that had suffered severe destruction of plant and equipment during the war. The toll from bombing was all too visible [...] Economists were called upon to access the implications of these wartime losses for recovery. In retrospect, it is clear that they overestimated the prospective retarding effects of these losses. The explanation that is now clear is that we gave altogether too much weight to nonhuman capital in making these assessments. We fell into this error; I am convinced, because we did not have a concept of all capital and, therefore, failed to take account of human Capital and the important part that it plays in production in a modern economy."

Thereafter, Schultz sought an all-inclusive concept of “capital.” He posited that the reason for which economists expressed such hesitation in designating human capital formation as a form of investment developed out of our own self-conscious abhorrence of our slavery tainted past, so that “our values and beliefs inhibit us from looking upon human beings as capital goods.” He noted that because the economic community has exercised a calculated resistance to the importance of human capital, measurements of total investments in the economy are often times grossly understated. Schultz argued that it is “the simple truth that people invest in themselves and that these investments are very large.” Improvements to education and healthcare can pave the way to increased standard of living especially in developing countries.”

Gary Becker (Nobel Laureate, 1992) contribution to this (and other fields in economics) also revealed a great capacity for creative thinking. His Human Capital (1964) utilizes economic theory, statistics and observations to demonstrate the importance of investment in education at all levels. [footnote]

Gary Becker, (1964), *Human Capital*, Chicago, IL: University of Chicago Press.

We have already seen in earlier modules that in developed and developing nations today, human capital investments far exceed those in physical capital, especially in developing nations. The size and potency of investment in human capital for economic growth is in large part due to the effects of human capital formation on stocks of knowledge and skills, especially its effects on the cumulative stock of knowledge. This is one of the great enduring investments in human capital: it tends to accumulate from generation to generation, while physical capital wears out and must be replaced every 5, 10, or 15 years.

There is by now very substantial evidence on the importance and effects of investment in human capital: it has long driven economic growth in the U.S. Several studies, especially NBER No. 8787,[footnote] conclude that in the final 25 years of the 20th century, human capital formation was far more important in the growth process than physical capital formation over the period, and as we have seen, since then.
Paul Beaudry & David A. Green (2002, February), “Changes in U.S. Wages 1976-2000: Ongoing Skill Bias or Major Technological Change?” NBER Working Paper No. 8787.

Clearly, the ratio of human capital to physical capital increased greatly over the past several decades (when human capital is measured as the number of effective units of skilled labor). Human capital formation has also had important effects on health in such nations as the U.S. [footnote]
David M. Cutler & Adriana Lleras-Muney (2006, July), “Education and Health: Evaluating Theories and Evidence”, NBER Working Paper No. 12352.

A study from (1999) also indicated that the age-adjusted mortality rate for high school dropouts age 25-64 was twice as large as those with some college.

Newer findings for the U.S., where human capital has been most studied, indicate that:

- An additional year of education increased earnings by 10% or $80k in present value over the course of a lifetime.
- The health implications of investment in human capital are notable.
- One more year of education led to increased life expectancy by 0.18 years in the U.S.
- Further, an additional four years of education lowers mortality by 1.8 percentage points, reduces heart disease by 2.16% points ,and reduces diabetes risk by 1.3% points. The interaction between human capital investment and health is therefore clear.

Later in this module, we turn to more explicit attention to investment in public health in emerging nations.

Varieties of Forms of Investments in Human Capital – Vocational Education

There is richness in experience in human capital formation that is not often recognized. The contribution of vocational education is an example. Here is an example of what can be done by resourceful people in poor countries for large payoffs for the poor. It is also one good example of the positive effects of foreign aid.

Vietnam: HOA SUA Vocational Training School

Over a ten year period from 2004-2014, the author made annual visits to Vietnam, first to help oversee the selection of scholars for a program that places students in PhD programs in science and public health, then as a member of the Board of Trustees of a new University there (Tan Tao, near Ho Chi Minh City).

In 2007, in a restaurant in a hotel in Hanoi, he came across a large group of young men and women being led about by a mentor, explaining food service and hospitality in leading hotels.

These young people turned out to be students from Hoa Sua School — which trained orphans, street children, and hearing-impaired young adults to place their skills in the job market.

Hou Sua was founded in 1994 by six retired Vietnamese women who set up a cooking school to transfer their skills. Within a few months they realized that orphaned and troubled youth in Hanoi had zero opportunity for school of any kind, not even vocational training. Scratching together funds, they opened a restaurant featuring Vietnamese and European cooking; a bakery, etc. Earnings from the restaurant financed the school.

Their fruitful work was noticed in 2000 by the French Government. The French Ministry of Foreign Affairs funded new buildings for the school at a new site. Then the school was linked to the Versailles Chamber of Commerce in France, enabling them to offer coveted diplomas called “Certificat d’Aptitude Professionalle.”

Hou Sua costs nothing to attend. It enables the orphans and abandoned children to earn a living and have a future. During its first few years school has trained and placed more than 3,000 professionals employed throughout the country.

The author carried away from this experience two main conclusions:

1. It reinforced the conviction that the most important investments a society can ever make is in human capital formation in very young people. This belief also happens is deeply rooted in many cultures:

   In Vietnam, every primary school by 2007 featured a big red banner across the front saying:

   > Plant a fruit tree and a farmer will benefit for 20 years. Build a school and society will benefit for fifty years.

   [footnote]

   This attitude is also found in other Asian nations and as we shall see 14th century Scotland. One of the best known sayings in Korean translates thusly:

> One step forward in education is ten steps forward for society.

Attributed to Ho Chi Min, in his letter to U.S. Secretary of State Jimmy Byrnes in 1945

2. The Hoa Sua School, and others like it in other poor countries, supports the view that the most effective form of foreign aid, by far, is that of investment in human capital formation. Indeed, as we will see in later modules, other than disaster relief, this may be the one of the few kinds of foreign aid that really helps those for whom the assistance is intended.

Innovative Approaches to Human K Formation: Education and Health

The Progresa program begun in Mexico in 1995 is This is another example of resourceful efforts to reduce poverty and at the same time enhance human capital. Mexico's efforts to reduce immiseration, especially in rural areas were mostly ineffective before 1995. The tools to fight poverty before that time were expensive, poorly administered subsidies on food and milk. Owing to information limitations, the government was unable to administer a means test. This meant that middle and upper income people got sizeable benefits, reducing benefits available for the poor.

In 1995, the Finance Ministry tried a "radical" new departure— "Give them the money." This was long the standard University of Chicago prescription for helping the poor. Rather than create a new agency of bureaucrats, just give the money to the poor.

Families were awarded cash to:

a. Keep children in school; and
b. Commit to regular medical checkups for children and mothers.

This is yet another program recognizing the inextricable links between income growth, health, nutrition, education, and lifetime earnings.

Did it work? After thirteen years of experience an article in Science magazine said yes.[footnote] But Mexico still has problems getting good schoolteachers.
“Skills, education, and the rise of earnings inequality among the “other 99 percent”, *Science*, May 23, 2014, 344(6186): 843-851.

Another very similar program was Bolsa in Brazil, a similar successful effort we discuss as a negative income tax later in this collection. The Bolsa Program also helped not only to enhance human capital but also served to remove Brazil from its unenviable position as the emerging nation with the most unequal distribution of income.

A similar program began in South Africa in 1998: The Child Support Grant (CSG) which provides direct cash transfers to low-income households from the public budget. The grant is subject to a means test: any family showing financial need receives $30 per child per month for all children less than 17 years old.[footnote] Two thirds of all families in South Africa are eligible for the CSG. This program is yet another good example of improving health of the poor by just “giving them the money”. It also serves as an excellent illustration of effective human capital formation: children in CSG families had improved growth, better attendance at school, higher physical stature, and decreased illness.[footnote]
“Hard Cash Boosts Child Health in South Africa”, *Science*, September 12, 2014, 345(6202):1264.
The program is still evolving. Many families that are eligible still are not receiving CSGs, leading some to argue for dropping its means test and provide unconditional cash transfers to every household with children.

Combining Physical Capital Formation with Human Capital Formation: Peru and the One Laptop per Child Program

For several years in the early 21st century, the author visited the Peruvian highlands each year to help monitor the economic development effects of a large gas pipeline running from the Peruvian Amazonian jungles, over the

Andes and to a port on the Pacific. On one such visit I learned that a 2007 World Bank/UN publication on primary education rated Peru's primary education system as dead last amongst 131 nations.

Beginning in 2008 the Peruvian Government began making a sizable investment in hardware to help rectify this problem. Little Green Laptops, pioneered by MIT media labs (one laptop per child) sold for $188 (2008). But highland villagers in Peru can barely afford pencils or paper, much less laptops.

So, the Government ordered and gave away 275,000 XO laptops to rural families. They were provided to help primary schoolchildren. The biggest problem early on was keeping older siblings eager to play computer games away from the machines so that primary schoolers can do their work.

These are hard-drive free machines operating on Linux with mesh wireless networks so each computer in each village can talk to computers in other villages.

Note that this human capital formation accomplishment required also physical capital formation (purchase of laptops). It is not at all unusual that human capital investment must be done in conjunction with physical capital investment.

Rates of Return on Education

Dozens of empirical studies since 1980 (especially from the NBER) confirm that a driving force in economic growth in all countries has been investment in skills and ideas – human capital − more so than investment in machines and buildings, also very important. We noted that many studies suggest that the annual rate of return on investment in public education worldwide is on the order of 20%. Rates of return on investment this high are rare indeed, worldwide.

Moreover, there is empirical evidence that investment in secondary education for females has a notably higher rate of return than that for males in several countries (Dowrick).[footnote]

Steve Dowrick (2003, May), “Ideas and Education: Level or Growth Effects? NBER Working Paper No. 9709.

The empirical studies cited do not fully include the positive effects of the effects of human capital formation on the introduction of new technologies: the more educated is the labor force, the more is the labor force able to implement technological advances. This has proven very important both for small, wealthy economies such as Australia and for all LDCs .

We may better understand the concept of human capital through some insights from that subdivision of economics called Public Sector Economics.

A high degree of accessibility to education is good for any economy, now and over the longer haul. Investments in education, whether public or private, share many commonalities with investments in physical capital; but there are major differences as well. A business that invests in a machine gets the exclusive benefits from the device. But when a taxpayer, or a donor, and/or a student invest in education (including higher education), the returns accrue not just to the students, but to society as a whole: new knowledge and new ideas can be used by millions of people simultaneously.

Second, investments in education depreciate much more slowly than investment in physical capital. This is largely because investments in human capital have a far longer useful life than investments in virtually all physical assets. The useful life of a vehicle used in a business is rarely more than eight years, that of a computer less than four. Therefore these physical assets depreciate over a period of ten and four years respectively. Physical assets such as plants and equipment also tend to wear out at an increasing rate while in service and require increasing levels of maintenance. Because investments in education have far longer useful lives (65-75 years) they depreciate at exceptionally low rates. And, the rates of depreciation do not rise notably over the years. With some exceptions, such as pure mathematics, skills and talents acquired by education deteriorate at very low rate, and vanish entirely only with the onset of advanced disease, or death. Over a century ago, the poet Oliver Wendell Holmes provided a near-perfect analogy for such an asset: “The Wonderful One-Hoss Shay.”

Greatly truncated, his poem goes as follows: " Have you heard of the wonderful one-hoss shay,
That was built in such a logical way,
It ran a hundred years to a day,
And then, of a sudden it…
Went to pieces all at once,
End of the wonderful one-hoss shay,
Logic is logic. That’s all I say.
"

Example: consider the gifted Physicist Richard Feynman, who, among other distinctions, was the father of NanoScience. He made contributions to physics right up to the moment of his death in 1988. Like his fellow physicists Albert Einstein and Edward Dirac, Feynman shared the same fate as the “One-Hoss Shay”.

Investment in education is very much like that in the mythical “One Hoss Shay.” It keeps paying, and paying, and paying, until death. The payout period for a machine is relatively short. The payout period for investment in education stretches over a working lifetime, now nearly six decades in rich nations and about five in emerging nations. With useful lives so long, and depreciation rates so low, it is no wonder that recent research has confirmed that returns to educational investment are so high. This claim is no less applicable to investment in research as in schooling. For example, the noted analyst Edwin Mansfield once estimated that the annual rate of return worldwide from academic research generally is on the order of 28 percent. Returns from investments in biomedical research are still higher.[footnote] Other studies have estimated the social rate of return on research and development to be four times the return on physical capital.[footnote]
See Charles I. Jones & John C. Williams (1998), “Measuring the Social Rate of Return to R&P “, *The Quarterly Journal of Economics,* 113(4):1119-1135, doi: 10.1162/003355398555856.
In NBER working paper No. 9709 Dowrick cites 5 studies showing private returns to research as about 20-30%, and in some cases nearing 50%.

Ongoing investments in education also provide the foundation for sustained economic growth over long periods of time. This is because better-educated parents are far more likely to have the income to make appropriate investments in education for the next generation, raising productivity all around. The effects are cumulative: the next generation is then enabled to make similar investments, and the next, and the next, resounding down through all later generations. On the other hand poverty also tends to resonate down through generations: children from very low-income families tend to have lower lifetime incomes.

For the United States, there is little doubt that investment in education and research generally, has been the chief engine of productivity growth over the past fifty years.

The pace and nature of economic and technological change especially in nanotechnology, biotechnology and information technology means that access to opportunity in the coming decades will be very good for those who have developed an array of skills— whether cognitive, quantitative, or artistic. These attributes will enable them to readily adapt over their lifetimes to the demands, not of multiple jobs, but of multiple careers. In turn, adaptive capacity depends upon the ability to convey ideas and information effectively, both orally and in writing. It depends also upon well-honed critical faculties: the ability to differentiate between junk science and real science, between bunk and brilliance, between degrees of evil, and then to build arguments founded on logic and integrity.

Those blessed with some of these advantages may look forward to a lifetime of challenge, achievement, and comfort available to precious few in past centuries. Those lacking these skills will, at best, be eligible only for lifetimes of quiet desperation, in hopeless enclaves where opportunities for the poorly schooled and unskilled will be as slender as in any recent period in human history. A decent life may be beyond their grasp, not to mention a decent living.

Adaptive capacity flowing from investment in education also allows people to better navigate tough financial times. The years 1980-2000 were unusual, in the sense of there were few serious recessions. But worldwide, the IMF (International Monetary Fund) has counted 113 episodes of financial crisis in 17 nations since 1975. And then, of course there was the very serious “Great Recession” of 2008-2010.

The experiences of India and Ireland are very instructive as to the efficiency of investment in human capital. India: From 1947 until about 1988, Indian economists spoke of the: “Hindu” rate of growth, an economic growth rate barely above rate of population growth. This was the period of Soviet style central planning, and the “License Raj.” It is no exaggeration to say that the “Decision Rule: for civil servants” under the License Raj was “whatever is not prohibited is required.”

Indira Gandhi’s second son, Rajiv Gandhi, began to move away from the “License Raj” as Prime Minister in the 1980s. Then, the transition from the License Raj unleashed significant growth, because a sufficiently educated populace was already in place. India was therefore poised to take advantage of reforms that finally allowed use of some private markets to allocate resources. India still has a long way to go in human capital formation-primary and secondary education remain deficient, and higher education very uneven in quality. But at least now nearly all Indian children attend school. Even so, the literacy rate in India in 2007 was barely above 50% for females and 78% for males, and reached a little over 65% for females and 82% for males in 2013. [footnote]
"Literacy," CIA World Factbook.

A similar phenomenon occurred in the so-called “Lynx” nations that used to be under Soviet influence of control: Estonia, Latvia, Lithuania, Hungary, Romania and Bulgaria. All six are blessed with a well-educated populace. From 1995-2005 several of these grew at 10% year, until the great recession of 2008-2010.

The experience of the Republic of Ireland is also illustrative. In the early 1960s, the Irish government began to expand significantly investment in primary and secondary education. Five decades ago, GDP per capita in Ireland was 40% that of the U.S.; but by 2006 Irish GDP per capita was nearly 80% that of the U.S.[footnote] Improvements in the quantity and quality of primary, secondary and university education set the stage for a flowering of economic growth after Ireland entered the European Union in the 1970s. Ireland simultaneously revamped its fiscal system, reducing high marginal tax rates to levels more conducive to the collection of taxes.
The Economist, May 27, 2006.

However, from 2008-2013 Ireland fell into very hard times due to truly misguided financial policy. While the years 2000-2007 were economic boom years, from 2009-2013 Ireland experienced bust, not boom. Ireland ran afoul of a bubble of its own making in 2008. By 2014, however, the Irish economy regained much of the previous lost ground. As the Irish case indicates, even very good policies on human capital investment do not insulate a country from the toxic effects of really bad financial policies, especially when a country cannot adjust its exchange rate, because it is a member of the European Community.

It is helpful to understand that, with at least one exception, mass education is a very recent phenomenon, even in now-developed nations. The exception: the Scottish Highlands. Because of the severity of weather and the poverty of the soils, education by necessity had to be a way of life for survival in the Highlands. Consider the MacKinnon family motto for the past thousand years: " Ye can be poor, ye can be oppressed.
But if ye educate the young, thy people can
ner' be suppressed;
rather shall ye prevail.
"

This sentiment persisted for centuries and culminated in the School Act of 1696. This Act was far ahead of its time. It sought nothing less than to teach all Scots how to read, write, and count. Because of this, no people were better prepared for the Industrial Revolution (1820) than the Scots, [footnote] who prospered in Britain itself as well as in the far-flung British empires.

See Arthur Herman, (2001), *How the Scots Invented the Modern World,* New York, NY: Random House, Three Rivers Press, Chapter 12.

Even in the U.S., schooling was far less available 50 years ago. In the late forties, less than 75% of children in the rural south went to high school. Common in grammar school classes were 15 year old farm boys just learning to read. Enrollment in K-12 grades is a much higher percentage in 2014, but the quality is suspect.

Several formerly poor nations have stressed education with excellent results. This is nowhere more apparent than in the East-Asia Pacific Region.

By 2003, 98% of primary school age children in this region were completing primary school. Virtually all the nations in the region are expected to boast 100% completion rates in 2015. It was no accident that this has been, by far, the region with the faster economic growth rates in the world, with average increases in real GDP of 7.8% from 1980 to 2007 (IBRD 2011).[footnote] East Asian nations have also had very sharp associated declines in rates of fertility and mortality. Moreover, income distribution in the region, as measured by the Gini index, tends strongly to be more equal than in the slower growing Latin American and African regions. In contrast to East Asia, primary school completion rates were but 59% for sub-Saharan Africa and 80% in South Asia, both regions where GDP growth rates were slower.

World Bank (2011), *World Development Report 2011*, Washington, DC: World Bank.

(Public Health See Science, September 2011). [MG to add]

There are very wide variations in public health indicators across emerging nations.

Consider infant mortality:

Number of Deaths per 1,000 Births 2009

1)	Afghanistan	147.0
2)	Chad	123.3
3)	Congo-Kinshasa	109.0
4)	India	95.0
5)	Ghana	67.0

6)	Tanzania	55.0

Infant mortality is higher in Afghanistan than India. Notably, there were no Latin American nations in this group.

Recognizing these important variations, we may consider some health indicators averaged across emerging nations.

Human Capital Formation in Public Health: Bottom-Up Approaches

Every 4 minutes, over 50 children under the age of 5 die.

In the same 4 minutes, 2 mothers lose their lives in childbirth.

Each year, 1.2 million people die of malaria, even though much malaria can be prevented by a mosquito net costing only $1.50.[footnote] Each year 3.5 million people die from cumulative effects of smoke from cooking fires. This problem has been particularly serious in the Peruvian Andes. The author has had first-hand experience with this problem where cooking fires have traditionally been inside houses.

See Eric Bing & Marc Epstein, (2013), *Pharmacy on a Bicycle*, San Francisco, CA: Berrett-Koehler Publishers.

Many deaths in emerging nations are not mainly due to medical problems that cannot be resolved. Rather, people are dying needlessly because of continuing logistical and organizational problems. Even in India, 50% of households lack toilets.[footnote]

Amartya Sen & Jean Drèze, (2013), *An Uncertain Glory: India and Its' Contradictions*, Princeton, NJ: Princeton University Press.

Top down approaches, directed and organized by central governments have largely failed to address logistical and organizational, as well as medical public health issues in poorer countries.

That being the case, there is a need to look to bottom-up approaches in the prevention and treatment of disease and early accidental death.

Most economics students by now have doubtless heard something of micro-finance. This has been truly a bottom-up approach, focused on lending to the poor in such countries as India, Indonesia, Bangladesh, Peru, and Mexico.

Microfinance has not been a cure-all, but it has quite clearly helped the rural poor in many countries.

A comparable bottom-up approach in public health holds out much promise. Examples include:

- Micro-clinics
- Micro-pharmacies
- Micro-entrepreneurs

These need to be located in rural communities, especially remote ones. A more focused "bottom-up" approach will require first a "scaling down" to local levels. Efforts to train and to provide incentives to all kinds of health care specialists need to be more focused in their own communities. Second this approach will necessitate the creation of large numbers of on-site professionals who can reduce the ravages of poor health, at a small fraction of the cost of top-down public health bureaucracies.

This model has worked fairly well in Asia, Africa and Latin America. A new book by Marc Epstein and Eric Bing shows why and how.[footnote] This volume shows, among other things, how when people are ill and cannot go out to a pharmacy, or a pharmacy is too far away, a local person with a bicycle can bring the pharmacy to them. In doing so, poor villagers predisposed to heart disease or stroke can be protected by a small (81mg) dose of aspirin dispensed from a bicycle-enabled pharmacy. Deaths from cervical cancer could be reduced by one simple drop of vinegar applied to the cervix by a locally-based clinician looking for cancerous cells.

Eric Bing & Marc Epstein, (2013), *Pharmacy on a Bicycle: Innovative Solutions for Global Health and Poverty,* San Francisco, CA:Berrett-Koehler Publishers

Children, especially young ones, could learn substantially more with inexpensive glasses, available locally. This is a much overlooked problem, even in the U.S.[footnote]
Ellen Byron, (2014, September 14), “Glasses Before Preschool”, *Wall Street Journal*, p.D1.

Such bottom-up approaches promise to make major inroads into public health problems. Still huge challenges in global health will remain. These are notably lack of basic health care - especially in rural areas. Millions of people die from preventable diseases. They lack access to even the most basic health care. Another challenge is fragmented health care. Major inroads have been made in reducing the incidence of AIDS in Africa in large part because of large scale but decentralized special programs financed by foreign aid including that begun under President George W. Bush in 2006. When the author first visited Zambia in 1983 the World Health Organization (WHO) officials there informed him that about 35% of males between the ages of 18-35 were HIV positive in Africa. The AIDS virus was, of course, transmitted to females who later became mothers. Only with aggressive programs has the incidence of AIDS in sub-Saharan Africa and worldwide declined notably. But much still remains to be done.

But, what does it mean when we prevent HIV transmission from a mother to child, when the child soon dies from diarrhea, malaria, or pneumonia? These maladies, unlike AIDS, have not been targets of large-scale preventive programs.

This is one illustration of fragmentation in health care in poor countries.

Foreign aid for supporting human capital, including public health, while never bountiful, has been in decline. Aid has up to now financed much of the bottom-up approach to improving health care. But there is a growing risk, especially given the continuing Medicare rates of economic growth in rich nations and the weaknesses of tax systems in emerging nations, that promising programs in locally oriented public health will not be financially sustainable.

[M.G. Need to Expand Public Health – see Science, September 2014]

The Chinese Experience

China was one of ten nations that have in recent years made great progress in reducing infant and maternal mortality.[footnote] The basic reasons for these improvements in China have been, first, the mounting of widespread and effective immunization programs, including that for Hepatitis B.[footnote] By 2013, China had the highest rate of the birth dose of Hepatitis B in the world: 96%.[footnote] Second, the Chinese government has subsidized costs for mothers giving birth in hospitals, thereby reducing health hazards from such complications as neonatal tetanus. One result of the program has been that the share of births in hospitals (as opposed to home births) increased by 46% from 1991 to 2013.

The others include Egypt, Peru, Bangladesh, Vietnam, Ethiopia, Laos, Rwanda, Nepal and Cambodia.

David Hillmers & Malcolm Gillis, "Initiatives in North Korea", prepared for Global Health Collaborative Advance 2013 Conference, March 23, 2013.

The Economist, July 26, 2004, p.37.

The Chinese experience from 1990 to 2013 indicates that focused approaches in public health improvements can lead to substantial reductions in mortality rates for both mothers and infants. By 2013, the mortality rate for children under five years of age was but one-fifth the rate in 1991. The maternal mortality rate fell by fully 71% over the same period.[footnote] Hepatitis B was very common both in China and North Korea in 1992. In China 10% of all children had contracted this disease in 1992. By 2013, the incidence of Hepatitis B had been sharply curtailed to only 1% in children. In that same year, Hepatitis B in North Korea was still among the highest in the world[footnote] and likely the major cause of widespread liver cancer.[footnote]

“Congratulations: Inoculations”, *The Economist*, July 26, 2014, p.37.

Hillmers & Gillis, op.cit, p.9.

See also Alessandro Zanetti, Pierre Van Damme & Daniel Shouvel, (2008), “Global Impact of Immunization Against Hepatitis B”, *Vaccine*, 26(49): 6266-6273.

The Role of Human Capital in the Services Sector

Until very recent years, human capital investments were viewed as important only for industrial sectors of emerging nations. But by 2010, economists began to pay closer attention to the role of human capital in generating growth in service industries, such as finance, trade, and health.

Conventional wisdom in economics has long held that in moving from a poor to a less poor economy, entrepreneurs and workers must move out of low productivity services (such as subsistence farming and services), and into manufacturing, where economies of scale prevail.

This path was taken by several nations from the fifties through the turn of the century, in such nations as South Korea and more recently, China.

Stress was laid upon the industrial sector, especially manufacturing. The services sector was seen as a graveyard for productivity, since it was assumed that in services there were no economies of scale.

But is this true in a world where human capital investment is important?

Services now increasingly require not only infusion of new technology but better educated workers. In fact, according to one prominent economist, the services sector has contributed more to growth in the U.S. since the 1980s than has the industrial sector.[footnote]
Jagdish Bhagwati (2012, February 9), *The Financial Times*.

In Nepal, Pakistan, and Sri Lanka the level of productivity is higher in services than in industry. [footnote]
See The Economist (2011, May 19th), “The Service Elevator: Can poor countries leapfrog manufacturing and grow rich on services? Retrieved from http://www.economist.com/node/18712351.

Advantages of the service sector:

1. The service sector can more readily employ women, partly because upper body strength is largely immaterial in occupations such as software development.
2. The service sector tends to be kinder to the environment than the industrial sector because it produces fewer effluents like smog,

chemicals, etc.
3. The service sector is subject to fewer stifling regulatory rules. [footnote]
   See Jadgish Bhagwati & Arvind Panagariya, (2013), *Why Growth Matter,* Washington, DC: Council on Foreign Relations, p.118.

Lessons: If a country is going to take advantage of the opportunities offered by services sector, a growing supply of skilled workers is needed. That requires, of course, emphasis on human capital formation.

Human Capital Formation – No Panacea

Investment in human capital formation is no panacea. It is one of the vital necessary conditions for economic growth and development. But it is not, by any means, a sufficient condition. There are many examples of nations who made large and continuing investments in human capital who have prospered mightily since 1950: South Korea, Malaysia, Ireland, Chile, etc.

But there are nations that have invested in primary and secondary education, and who have achieved high literacy rates etc. but have enjoyed very limited or no economic growth over long periods. Examples from the past fifty years include North Korea, Russia, Bulgaria from 1950-1990, and China from 1950-1982. These communist governments were rather successful in spreading education, especially primary and secondary. By 1990, just before the collapse of communism in Europe, adult literacy rates in most communist states were nearly as high as Europe and the U.S.: this should have been a great platform upon which to build.

Consider the following literacy rates in 2009:
U.S. 99%, Italy 97%, Spain 96%, the rest of Europe 99%
Hungary 99%, Czechoslovakia 99%, Poland 90%, China 68%.

The economies of the communist Bloc nations, including China, grew slowly from 1950-1990. However, after 1991, when markets were reintroduced, the formerly Eastern and Central European communist nations began to grow fairly rapidly, largely because the human capital base was already there, and it could now be used in combination with new types of investment in physical capital, new trade opportunities etc.

Consider China

In China in 1985, literacy rates were 68%. By 2006, the male literacy rate in China was 96%, a 50% increase in only 20 years.

And Chinese economic growth? From 1990 through 2008, Chinese economic growth later averaged more than 10% per year. At a growth rate of 10%, how long would it take to double income? (Answer: about 71/2 years).

The human capital story is heartening, but there are some thorns among the roses.

One example: although gross enrollment ratios for grades 1-5 in India reached 100% in India by 2008.[footnote] A government of India report[footnote] says that the percent of fifth graders who read on at least a second grade level has dropped from 58% in 2007 to 54% in 2011. Half cannot read at second grade level. And university education, or the percent of population enrolled in college or university in 2007, was 13%, far lower than Brazil (30%) or China (22%).[footnote]
Jadgish Bhagwati & Arvind Panagariya, (2013), *Why Growth Matters*, Washington, DC: Council on Foreign Relations, p.190.
Annual Status of Education Report (ASER) (Rural).
Jadgish Bhagwati & Arvind Panagariya, (2013), *Why Growth Matters*, Washington, DC: Council on Foreign Relations, p.136.

A Digression: Technology, Internet, Cell phones and Human Capital

As we have noted, ordinarily a nation must have made sizeable previous investments in human capital formation before experiencing any notable growth from technological progress.

However, the 21st century is so far showing that certain kinds of technological change can lead to rapid improvements in income even while a nation tries to build up its base of human capital from low levels.

By the year 2010 the rapid spread of mobile phones began to have very significant and unforeseen results for financial development, agricultural development, and efficiency in markets, and even in public health.

New research by Christine Zhen-Wei Qiang, Robert Jensen, and Aparajita Goyal shows, among other things, the following:[footnote] the internet and mobile phones boost growth. The impact, as one would expect, is greater in poor countries than in rich ones, because of the very poor pre-existing communications infrastructure in poor countries. (This reflects, of course, lack of investment in physical capital).
The Economist, (2010, January 7th), “Worth a hill of soyabeans.”

The growth promotion effects are even greater for the internet than for mobile phones, as we shall see. But mobile phones have mattered greatly.

Consider all mobile phones. By the year 2000, poor nations had 175 million mobile phones (1/4 of the 700 million world total). By 2009 the number of mobile phones in poor nations reached three billion (3/4 of the world total).

In poor nations, for every ten percentage points increase in mobile phone availability, GDP per capita rose by 0.8 percentage points (in rich nations it rose by 0.6).[footnote]
Ibid.

And, in poor nations having dial-up Internet access, every ten percentage point increase in adoption, was associated with an increase in GDP growth of 1.1 percentage points.

For broadband Internet, in poor nations every ten percentage points of increases in adoption, was associated with a 1.4 percentage point increase in GDP per capita.

Finally, there have begun to appear some potentially significant unforeseen feedback from spreading use of smartphones. There are now cell phone stethoscopes, cell phone microscopes (for imaging cells and parasites), remote diagnoses of disease, etc.[footnote]
The Wall Street Journal, (2013, September 21).

Promising New Approaches in Assessing Human Capital Formation Policies

We have seen that the idea of human capital formation first took shape in the mind of Nobel Laureate Theodore Schultz in the 1940s. By the turn of the century virtually all economists had recognized its importance. As the field expanded, new analytical and empirical tools developed to help us understand the implications.

One of the most promising of these new tools (new to economics, but not to medicine) has been randomized control trials (RCTs), first pioneered in economics by two MIT economists, Abhijit Banerjee and Esther Duflo.

Since 2003, their lab has mounted nearly 450 RCTs, focusing on human capital as well as issues in finance and other fields. With the publication of their highly regarded book, Poor Economics[footnote] in 2011, economics, especially development economics, has been greatly enriched. The authors, and others who utilize RCTs, typically focus on problems affecting the very poor, most who live on less than $1 U.S. dollar per day.
Abhijit Banerjee & Esther Duflo (2011), *Poor Economics: A Radical Rethinking of the Way to Fight Global Poverty*, New York: Public Affairs Press.

In the area of human capital, RCTs have shed light on issues ranging from the efficacy of remedial classes in primary and secondary education in India and Ghana, the effects of raising teachers’ salaries in India, the effectiveness of spending on preventive measures in health in Africa, and the effects of labor market policies, among many other policy issues.

Randomized control trials have long been a staple in medicine, especially in the testing of pharmaceuticals. In these clinical trials a group of patients is

given a specific drug while another group receives placebos. The groups are chosen at random. The application of RCTs in economics has revealed some interesting findings, many of which run contrary to previous received wisdom on education, health, and subsidy programs.[footnote]
(See Duflo and Banerjee, Poor Economics).

Conventional wisdom has long held that factors such as raising teachers' salaries, doubling the number of teachers, or improving curricula, would significantly increase learning. RCTs conducted in India on teachers' salaries and in India and Ghana on doubling the number of teachers suggest that at least in those settings, the impact of these measures was minimal. However, expansion of remedial education classes turned out to have very significant positive impacts.

RCTs have also been deployed to illuminate important issues in health. For example, low income families typically do not spend nearly enough on disease prevention, largely because of the costs of doing so are beyond their reach even when these costs are very low. One of the RCTs deployed in Kenya by Jessica Cohen and Pascaline Dupas shows that the health payoffs from free provision of water purification tables and bed nets to prevent mosquito bites (and therefore reduce malaria cases) can be quite significant.
[footnote]
(Ibid, p.49)

The work of Banerjee and Duflo and others utilizing RCT approaches is also interesting for another reason: it confirms one of the main themes of this book; that poor people generally try to pursue their best interests; they are not at all stupid but lack of information or the presence of misinformation often impedes or precludes their pursuit of their best interests.

Human Capital Deformation: Son Preference

Economic inequality, economic growth and gender imbalance are all bound up together in one big sticky ball of wax.

Consider, to begin with, China in 2010:

- The fertility rate was 1.4, far below the replacement rate.
- People above age 60 were 3.1% of the population. This percentage will grow rapidly, owing to the one-child per family policy.
- People under age 14 were 17% of the population (in 2000 the percentage was 23%).
- By 2013, there were 8 people of working age for everyone older than 65. By 2050, there will be only 2 people of working age for everyone over age 65. It might be said that as result of government policies, China will get “old” before it becomes rich.

In addition, China shares with some regions of India, the Korean Peninsula, Afghanistan, Taiwan, Singapore, Vietnam, and some nations in Central Europe a strong cultural imperative for male offspring.

When this cultural imperative interacts with China’s one-child per family policy, a large gender imbalance results.

Before the spread of ultrasound technology in China, this meant a large number of female infanticides. After ultrasound became more accessible, sex-selective abortions rather than infanticide were common.

Nobel Laureate AK Sen once wrote an article “More than a Million Women are Missing”.[footnote] He was referring to infanticide or abortion of female fetuses.
Amartya Sen (1990), “More Than 100 Million Women Are Missing”, *The New York Review of Books*.

Consider that in humans, nature provides a sex ratio of 950 girls for every 1000 boys at birth. This has arisen by natural selection, because of higher mortality rates for boy infants.

Put another way, nature provides about 105 boys for every 100 girls.(This is the standard way of defining the concept).

Consider the Chinese, Indian, and Korean experiences:

In China in 2010 among newborns, there were 118 boys for every 100 girls. One implication: as this age cohort grows up, there will not be enough brides for nearly 20% of today's baby boys. Little imagination is required to assess the social, economic and even military implications of this development.

The foregoing is a result of strong son preference; coupled with easier availability of sonograms.

Social scientists used to say that son preference in poor countries would decline as per capita income rose above subsistence levels.

Is this happening? Not much in China. It is happening, maybe in some regions in India, but not in Northern India's richer parts.

In China, richer regions such as Shanghai and Guangzhou have much higher rates of son preference than in poorer provinces, i.e. they have a higher rate ratio of boys at birth than girls.

In India, the picture is mixed. The census data for 2008, compared to that of 2001, shows a rising male-female sex ratio in four states. The variation in India still has not been satisfactorily explained. [footnote]
The Economist (2011, April 7th), "Seven Brothers."

Table 1 **India Selected States - State Ratio at Birth** **Boys per 1000 Girls** **2001 and 2008**		
	Ratio 2008 **Boys to Girls**	**Ratio 2001** **Boys to Girls**
Punjab	121	130

Table 1 **India Selected States - State Ratio at Birth** **Boys per 1000 Girls** **2001 and 2008**		
Delhi	114	120
Andhra Pradesh	111	112
West Bengal	105	105
Kerala	109	113

Source: “Gendercide in India”, the *Economist*, April 7, 2011

It is worth noting that South Korea also displayed high rates of son preference from 1950-1990. But the sex ratio at birth peaked in 1990 and is now approaching the natural level, of 109 males to 100 females. A major reason for this development was that in the late 1990s, South Korea, already concerned about falling fertility rates, outlawed the use of sonograms for sex selections; one result was a rise in the ratio of girl to boy births in South Korea.

India has also banned ultrasound scans for the sole purpose of fetus sex determination. Also in India, sex-selective abortions are nominally illegal, but these bans have proven difficult to enforce.

Figure 1

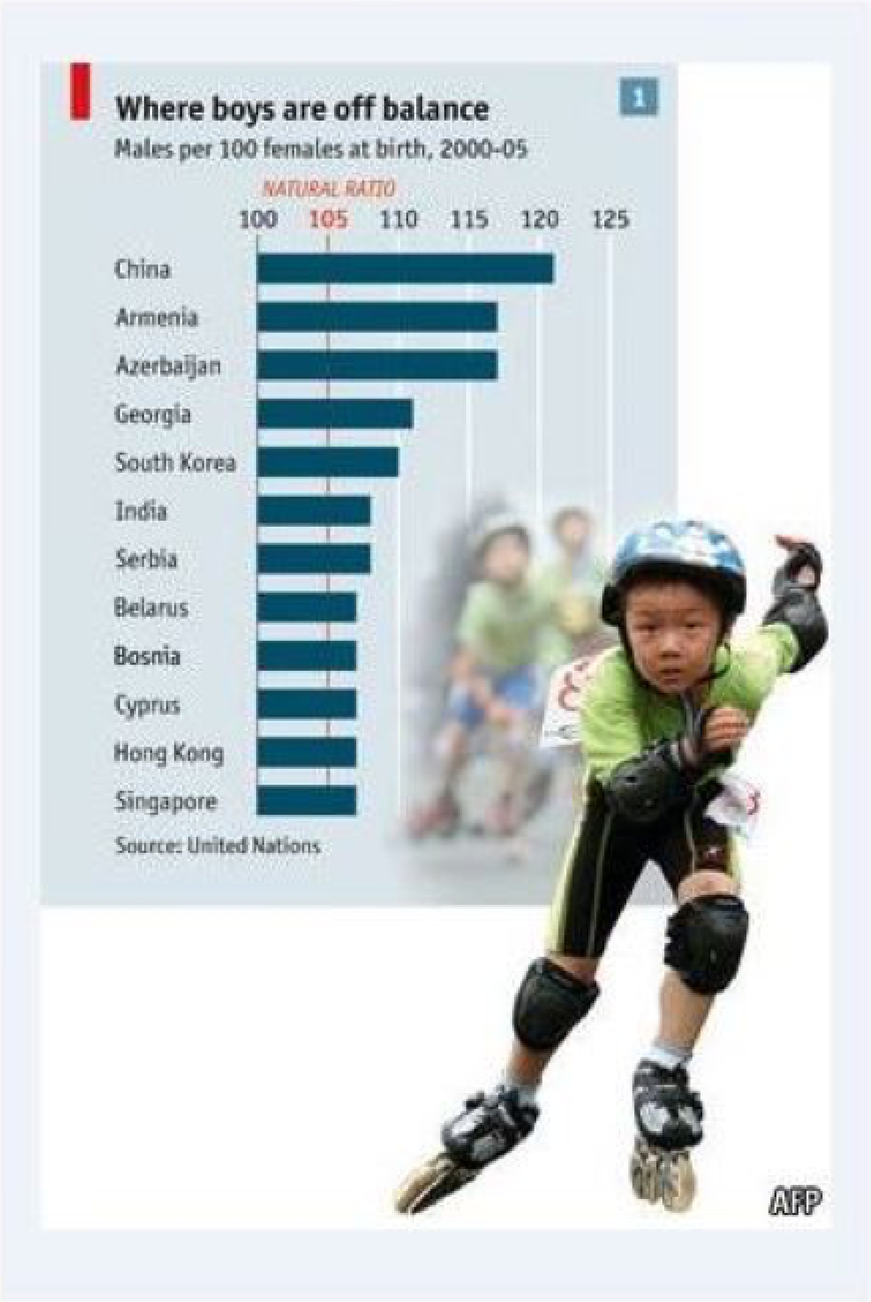


Figure from *The Economist,* March 6, 2010

Note that in societies where 4, 5 or 6 children were common in the 1960s, a boy would almost certainly come along eventually. So son preference did not need to come at the expense of daughters.

Many societies besides India and China exhibit significant son preferences, including Vietnam, Brazil, Singapore, Taiwan, and the Balkan Nations in Central Europe. But son preference has been much more skewed in China and, until recently, India (see Table 2).

When son preference is combined with low or falling fertility rates and the availability of ultrasound screening, the incidence of abortion of female fetuses tends to be high.

What are the Historical Reasonc for Son Preference?

1. Need for males with strong upper body strength to do aggressive physical work and do battle.
2. In some places the high dowries families have to pay in a daughter’s marriage. (India).

The Chinese One-Child Policy: A Brief Overview

Originally enforced by the Chinese politician Deng Xiaoping, the one-child policy has at its core belief a Malthusian mechanism, which posits that unchecked population growth forever dooms a society to poverty.

Prior to the introduction of this policy, population growth was in China was initially regarded as an economic advantage, a belief furthered by Mao Zedong who famously proclaimed in 1949, “Of all things in the world, people are the most precious.” [footnote] Under Mao, government policies denounced birth control and also banned imports of contraceptives. But continued population growth, aided by improved sanitation and medicine and accompanied by an overall economic conversion from agriculture to industry, caused a rethink of Mao’s policy.

See Laura Fitzpatrick, (2009, July 27), “China’s One-Child Policy,” *Time*.

Table 2
Son Preference
Note: “Nature’s Ratio” = 105
Males per 100 females at birth 2000-2008

China	118 (was 120 in 1999)
Armenia	117
Azerbaijan	117
Georgia (Asia)	110
South Korea	110
India	108 (census data) 102 (sample survey)
Serbia	108
Belarus	107
Cyprus	107
Hong Kong	107
Singapore	107

Source: U.N.

A new Slogan was adopted “Late, Long and Few.” Some initial success in this policy led to the current one-child policy.[footnote] Before 1997 it was often the case that for couples who broke the one child policy their houses were torn down. And as late as 2005 many women were made to undergo sterilization, sometimes by the use of force.
Li et al., 1993.

The one-child policy in its original version restricted most urban couples to have one child, rural couples to two: an extra child could incur fines up to 100,000 yuan or about $6,000 U.S. at the time, an amount in excess of per capita income in China. Since its implementation, the policy is reputed to have prevented perhaps 400 million births. Future implications of the policy include the rapid aging of society.

There were, however, some positive shorter-term changes from the one-child policy.

1. It fostered some financial and social independence of those Chinese women who as infants survived the ultrasound scan. Daughters with fewer siblings, especially in urban areas, are more likely to receive secondary and higher education, and therefore have the possibility, at least, of greater financial independence.
2. The enforced family planning also freed some Chinese women from some rigid traditional duties of childbearing and childrearing.
3. In China, sons stayed in the family after marriage whereas daughters usually moved to the homes of in-laws.

Question: Will the new leader Xi Yinping, who took over in 2012, take a fresh look at the one-child policy and perhaps modify or end it?

Some Unforeseen Economic Effects of Interaction of Falling Fertility Rates, Son Preference and Later Marriage Age

While we lack the space to cover all possible economic effects of major demographic shifts now underway, there is one further demographic change happening that will have significant effects on population growth: the rising age of marriage (also happening in the U.S.). In Hong Kong, Singapore and Japan this is called “The Marriage Strike.”

Women are either not marrying or, more commonly, postponing the age of marriage and their first childbirth. (Consider the 2010 Hong Kong average age of childbearing: 31.4 years).

If we combine the effects of:

1. Falling fertility worldwide
2. Son preference in many nations
3. Rising age of first marriage.

In more than eighty countries, if present trends continue, the result will be that women will increasingly not have enough daughters to replace them, unless fertility rates rise and unless son preference becomes less common.

Table 3
Year in Which Population Disappears (assuming no immigration) (Given Extrapolation of Present Trends)

Hong Kong	2798
Portugal	3000
Austria	3001
Singapore	3002
South Korea	3015
Poland	3015
China	3035
Thailand	3040
Germany	3050
Russia	3050

Table 3 **Year in Which Population Disappears (assuming no immigration) (Given Extrapolation of Present Trends)**	
Italy	3060
Spain	3012
Iran	3065
Canada	4030
Brazil	500
Japan	3035

Source: United Nations ______

Consider an extreme case: Hong Kong:

There, a cohort of 1000 women is now expected, given present fertility rates and son preference, to give birth to 547 daughters. If fertility rates and son preference stay consistent, then these 547 daughters would bear 299 daughters of their own, and so on until they no longer reproduce.

The result: in just 25 generations, Hong Kong's population would fall from 3.75 million today to just one in 2798. Given Hong Kong's fertility rate and average age of first marriage, the last woman to be born in Hong Kong would be in the year 2798. And by the next millennium, there would be only one person in Germany, Italy, Japan, Russia, and Spain. China would have 1500 years left before reaching this extreme outcome.

However, it is not likely that such extreme outcomes will actually materialize. Reasons include:

- Fertility rates could move up to 2.2 or 2.3

- Son preference could fall to such as to stabilize the ratio of male to female births
- The average age of marriage may decrease slightly, or at least not increase.

This exercise depicts some of the startling things that could occur if present conditions are extrapolated into the long run.

The same could be done with mortality rates. What if a child born today has a life expectancy of 95 or 100? What will this mean for employment? For social security systems, etc. etc.

In any case, the entire world has been experiencing very marked demographic change. When these are mixed with technological changes and economic changes it is a safe bet that the future will not much resemble the present.

21ST CENTURY TECHNOLOGY, DIGITAL DISPLACEMENT, AND THE ROLE OF HUMAN CAPITAL FORMATION

Technology without doubt has long been a strong determinant of development. More recent technology developed in the last three decades of the past century and the first 15 years of the 21st century has created opportunities for, and challenges to, economic growth and development that little resemble those of the past thousand years.

Even so, technological change, as well as stagnation in technological change, had important impacts on economies and societies for several millennia.

Major innovations in technology stretch back over 6,000 years, when biotechnology was first used to leaven bread and ferment beer, using yeast (see Table 1).

YEAR	**TECHNOLOGICAL INNOVATION**
500 BCE	The first antibiotic appeared in China when soybean curds were used to treat boils.
First Century CE	Heronas of Alexandria presented and operated the world’s first steam engine. However, the invention was used only to open and close doors of temples to the Gods, and steam was lost to the world in commercial application until the late 18th century.
1590	Zacharias Janssen invented the microscope.
1675	Anthony van Leeuwenhoek discovered bacteria.

YEAR	TECHNOLOGICAL INNOVATION
1763 - 1775	James Watt’s improvements on the Newcomen steam engine allowed steam to become the power source for the industrial revolution.
1797	Edward Jenner used the first successful vaccine to protect humans from smallpox.
1865	Gregor Mendel began the science of genetics.
1928	Alexander Fleming discovered penicillin as an antibiotic.
1940s	Electronic computers were first used.
1980	The word processor was born.
End 20th Century	The announcement of a rough draft of the entire human genome.[footnote] Malcolm Gillis, *The Economic History of Technology*. (In progress, 2014).

6,000 Years of Technological Innovation

The technological innovations cited above surely improved human welfare not long after they were put into place. However, it is rarely recognized that technologies that are 500 or even 3,000 years ago are still yielding benefits in the 21st century: as one group of analysts put it in their study of older technologies in over 100 nations, the long eons of technological history still matter today[footnote], including and especially for emerging nations. Diego Comin, William Easterly and*Was the Wealth of Nations Determined in 1000 B.C?* Cambridge, MA: National Bureau of Economic Research, Working Paper #12657.

Examples of long-lived technological impacts include two transport technologies in 1000 B.C.E.: vehicles and pack animals. But technologies

developed around 1500 C.E. have had (unsurprisingly) even more contemporary impact. These innovations include ships capable of crossing oceans, magnetic block printing, the use of steel, gunpowder-based weapons and much more”.[footnote]
Ibid. p.10.

In the 21st century, new and startling applications of information technology, nanotechnology and biotechnology promise to vastly improve how we live, how well we live, and how long we live.[footnote]
Malcolm Gillis, *Perspectives on 21st Century Technology: The Nano-BIO-Info Convergence*. Prepared for the 10th Annual Rhodes Conference, Greece, October 3-8, 2012.

We will see that the 21st century technological revolution brings mixed blessings. For example, in the U.S., in 70 out of 71 technology-oriented jobs, the median income is greater than that for all occupations. Moreover, in 57 of these occupations, the median income is at least 50% greater than the median for all industry. [footnote] As one analyst put it, “the high-income economy must be the high-tech economy."[footnote] At the same time some technological innovations, especially in information and digital technology, threaten to lead to a growing displacement of labor in production processes in the U.S. and around the world. We will see that while 21st century technology may bring to humanity the “best of worlds,” some, it could also bring the “worst of worlds,” such as that depicted in Kurt Vonnegut's novel, Player Piano in 1952, six decades ago. In that world, giant computers reigned, making all decisions, while displaced humans faced a bleak, purposeless future. Vonnegut’s novel was published but two years before Alan Turing, the 20th century pioneer of the computational age, died. Turing formulated the “Turing Test” to determine if “machines could think.” He believed that by 2000, there would be such machines.
See Gregory Tassey (2014, Winter), “Competing in Advanced Manufacturing: The Need for Improved Growth Models and Policies,” *Journal of Economic Perspectives*, 28(1): 27-48.
Daniel E. Hecker (2005, July), “High Technology Employment: A NAICS-based update,” *Monthly Labor Review*, 128: 57-68.

Since the late 1970s there have been two distinct waves in the evolution of manufacturing technology, especially digital technology. The first, covering the period from about 1980 to 2010, allowed substantial economic activity in manufacturing, design and research to move from wealthy countries to those poorer countries that had then investment in human capital and adequately trained labor forces available at low wages relative to the U.S. and Europe. Over that period, many emerging nations - such as Korea, China, and Malaysia - first acquired manufacturing technology from industrial nations and then forged the capability to develop the technology within country, and so become increasingly competitive in international markets for goods.[footnote] Without doubt, this first wave led to notable and, in some cases (China), even marked improvements in per capita incomes and consumption. Across the earth billions of people in China, India, Vietnam, Indonesia, and Brazil were lifted out of poverty. Indeed, by 2014, China possessed the world's largest manufacturing sector.
Tassey, op. cit, p.29.

And it should be stressed that even by 2014 countries that feature cheaper labor remain, for now, attractive destinations for foreign investment by Japanese and even Chinese firms. For example, Japanese firms in 2013 have made substantial investments in such relatively low-wage nations as Laos, Cambodia, Vietnam and even Thailand, where workers salaries have increased by 40% since 2012.[footnote] Japanese companies invested about $10 billion in Thailand in 2013. Vietnam has attracted almost $3 billion from Japanese firms. Chinese companies have invested heavily in low wage Cambodia where wage costs are one-third of that in China. There, Chinese firms invested 10 times more than did Japan between 2005 and 2012. Investment by Chinese firms in Laos was 4 times that of Japanese firms. [footnote]
Warangkana Chomchuen and Mitsuru Obe (2014, September 30), “Japan Inc. Goes Deeper into Southeast Asia”, Wall Street Journal, p.B-8.
Ibid, p.B-8.

The second wave of innovation in digital technology promises to be much less benign for low skilled and low-wage workers everywhere. This wave will allow firms to steadily reduce the use of labor in performing complex tasks.

Nobel Laureate Michael Spence succinctly described the implications, with obvious effects for emerging nations. "The process of labor substitution has been underway for some time in services sectors… such as ATMs, online banking, enterprise resource planning, mobile payments systems and much more. The revolution is spreading to the production of goods, where robots and 3D printing are displacing labor… In other words, unlike the preceding wave of digital technology, which motivated firms to gain access to and deploy underutilized pools of valuable labor around the world, the driving force in this (second) wave is cost reduction by the replacement of labor."

As Spence notes, an extreme form of this shift away from use of labor may be coming in the form of 3D printing, also known as additive manufacturing.[footnote] A subsequent section of this module portrays some of the implications for 3D printing for labor utilization in emerging nations and the future of international trade generally.
See Michael Spence (2014, May 22), "Labor's Digital Replacement" in *Project Syndicate*, The World's Opinion Page. See also Martin Baily and Barry Bosworth, (2014, Winter), "US Manufacturing: Understanding Its Past and Its Potential Future," *The Journal of Economic Perspectives*, 28(1): 20.

In the period 1987-2011, the computer industry became by far the best-performing portion of U.S. manufacturing. However, much of the industry has moved abroad. By 2012, the U.S. transitioned from being the world leader in producing computers to one among many leaders,[footnote] and computer services can now easily be incorporated into foreign production of computers. This is both good news and bad news for technologically ambitious emerging nations: it helps to improve living standards, but it also will likely mean, as in the U.S., a decline in the share of employment in manufacturing; especially in jobs paying good wages. It will likely also mean further declines in labor's share in U.S.
Ibid., p.7.

In any case, the implication of the second wave of digitization will be far reaching, not only for developing nations, but also for higher income nations in North America, Europe and East Asia.

For developing nations, cheap labor is already becoming less important in manufacturing and income growth generally, with obvious effects on income inequality.

The recent experience of developed nations may foreshadow what may be in store for poorer nations' labor markets. For richer nations such as the U.S., the digital revolution has been a major factor in the increasing "polarization" in the U.S. labor market.[footnote] The number of jobs requiring medium levels of skills has diminished, while the numbers of jobs requiring high and low skills has grown, again with obvious implications for income distribution.
Source: David H. Autor, Lawrence F. Katz and Melissa S. Kearney. 2006. "The Polarization of the US Labor Market," *American Economic Review*, Papers and Proceedings, 96:189-194.

This is a relatively recent development. In the U.S. before about 1990 low skill jobs tended to be replaced by high skill jobs, but the number of middle skill jobs remained fairly constant. Polarization in the labor markets of the U.S. began to grow in the 1990s. It accelerated with the economic meltdown known as the "Great Recession" of 2008-09 (discussed in later modules).

Whereas the shift away from labor in poorer nations has been most keenly felt in low-skill employment, the shift in the U.S. has, until recently, been away from middle skill jobs. But essentially one prime cause is behind both: the growing automation of routine tasks made possible by the second wave of the digital revolution (involving, among other things, increasing utilization of robotic devices in manufacturing). As noted in a study by the Federal Reserve Bank of Dallas this has been largely due to the vastly increased availability of computing power since 1990, as well as a rapid reduction in its costs.[footnote]
See Anton Cheremukhin (2014, May), "Middle-Skill Jobs Lost in U.S. Labor Market Polarization," *Dallas Federal Reserve Economic Letter*, 9(5).

Concern over displacement of labor in economic activity is by no means confined to the U.S. Similar patterns of polarization in labor markets have emerged in 16 developed European nations.[footnote] A recent study for

Britain estimates that as much as 47% of occupations there could be fully automated in the next few decades.[footnote]
Maarten Goos, Alan Manning and Anna Salomons (2009, May), “Job Polarization in Europe”, *American Economic Review, Papers and Proceedings*, 99(2): 58-63.
Carl Benedikt Frey and Michael A. Osborne (2013, September 17). "The Future of Employment: How Susceptible are Jobs to Computerisation?" U.K. Oxford: OMS Working Paper.

Some of the implications of the second wave of digitization for income inequality in rich nations and for both income distribution and income growth in developing countries are not pleasant to contemplate.

However, options exist to help moderate the ill effects of these trends if we bring to bear the lessons of the previous chapter: the importance of human capital formation. Technological innovation will cause many present jobs to vanish, while others will be fundamentally changed. Human labor will still be essential, but only to the extent that human capital formation keeps pace with technological innovation. For the future, both in rich and poor nations, this will require not merely improvements in the quality of education for the young, but in the need for lifelong programs for continuing human capital formation, to enhance human skills throughout the life of both workers and managers.

Technological Innovation and Foreign Trade

According to the archeological record, the history of international trade extends back at least 4,500 years, when linen, wool and hemp were shipped from the Indus River Valley (in what is now Pakistan) to cities in what is now Eastern Iran.

Trade expanded slowly during the Bronze Age, when Phoenicia brought tin from Wales. It flourished during Roman rule from about 200 BCE to 500 CE, and then slowed down after the Black Plague in the 14th century. After that it grew in kicks and starts, until about 1820 through 1914. Trade entered a flourishing new era after 1970, when emerging nations began to reap sizeable benefits from globalization.

But that may be all about to change, if the potential of digital manufacturing (or additive manufacturing) is realized, particularly as the prices of equipment and software used in the industry continue to decline.

We may speak of not one, but four industrial revolutions. We have noted in earlier chapters that the first Industrial Revolution began in about 1810 in Britain and then spread to the U.S. and the rest of Europe. The second Industrial Revolution arrived with the invention and adoption of the assembly line in manufacturing. The third was spurred by the first wave of the Digital Revolution, beginning in about 1980. There are those who believe that a new wave, relying increasingly upon additive manufacturing, will usher in a fourth Industrial Revolution before 2025.

Additive manufacturing is a process that utilizes 3D printers to build up objects from small particles. The first printers used were either ink or powder. Today printers can print metal parts and even human tissue, building them by depositing materials layer by layer. Up until about 2010, the technology was used mostly to build prototypes and early production runs for small, complex components.[footnote]

Martin Neil Baily and Barry P. Bosworth (2014, Winter). “US Manufacturing: Understanding Its Past and Its Potential Future,” *Journal of Economic Perspectives*, 28(1): 20.

Why is it called additive? Manufacturing as we have known it before is subtractive. For example: making an aircraft part today requires expensive, lightweight titanium. Before one took solid titanium billets and machined them into parts. This results in about 90% of the material being subtracted, or cut away. This is called swarf, and is no longer of any use in making an aircraft, and much of it is waste.

Additive manufacturing of the same aircraft begins with titanium powder. Then, software instructs the 3-D printer to spread a very thin first layer (0.02 mm) on a tray. Then the powder is fused by lasers. Then added to the first layer is another layer, and another, and another, etc.

The additive process uses only 10% of the titanium raw material used in subtractive manufacturing. And the part is lighter, requires much less energy to make, and can be customized very cheaply. In addition, this will eventually mean that firms no longer need to hold expensive inventories of parts. Rather, they will just print what you need, when you need it.

How appealing is this for the 21st century for, say, the aircraft industry?

- Environmentally it is very good. It saves energy and avoids depleting titanium reserves.
- It can be commercially cheaper. Because prototypes or parts can be easily made, it can slash development costs for new products, sharply reduce waste of materials, and eliminate tooling costs.

An example of the simplest types of additive manufacturing would be non functional plastic prototypes for almost anything. Consider firm Alpha in Houston, TX: Engineers design a T-pipe, using the Solidworks 3D program. Then firm Alpha sends the file electronically to a 3D printer located at firm Beta in Lexington, Massachusetts. This printer uses powdered ABS plastic (very cheap). The part is produced layer by layer.

- The access T-pipe is a miniature of a much larger solid pipe.
- The prototype bearing is made to see if it will fit into the machine properly. If the plastic prototype works, then the company will make the real thing by using metal powder.

That is a very simple example of one technique in digital manufacturing. But there are at present five different additive technologies used in 3D printing.

By 2014, surprising new applications are appearing. Engineers at the University of South Hampton in England recently printed a flyable aircraft (not yet including its engine). The firm Rolls Royce however has been developing a process to use 3D printing in making aircraft engines. In 2015, the U.S. metals producer Alcoa had developed a 3-D printing process to make gas turbines for jet engines. The results have been striking. With additive manufacturing, Alcoa has managed to: a) cut in half the time required to manufacture the part; b) reduced costs of the process by 25%; and c) a process that once required half a year can now be completed in two to eight weeks, enabling large increases in output.[footnote] The automaker Audi now is printing parts of its autos with 3D printers. 3D printers can

print new teeth for you, and 3D printers can print a customized hip replacement or knee replacement for you (at no greater cost than now). 3D printers are also used to print sensors on military armor, and to make plastic water tanks using embedded electronics to measure how full the tank is, with pumps to turn water on and off. At major NASCAR races, technicians have been using 3D printers to replace, in real-time, racecar parts that have been damaged during races.
See Fortune, "Using 3-D Printing to Make Jet Engines", November 13, 2014.

The advent of additive manufacturing has far-reaching implications that may drastically change manufacturing and trade, as well as missions into space. Significantly in September 2014, the U.S. Aeronautics and Space Administration (NASA) sent a 3D printer to the International Space Station. The printer will be used to provide real-time replacement parts at the station, enhancing safety as well as efficiency.

Digital manufacturing enables firms to produce on the 3D printer what they formerly had to order from a local or foreign supplier. The vast inventory yards of large oil companies, such as those of ARAMCO in Saudi Arabia, stretch over dozens of hectares. This will be an unusual scene by 2025.

3D printing has major implications for inventory management and transport costs.

1. *Inventory Management*
   Holding inventory is expensive. Companies may no longer need to go to the expense of holding large inventories of certain types of goods, materials and spare parts.
2. *Transport Costs*
   Today, transparent costs are a large percent of total costs of goods sold: goods are shipped by planes, trains, boat and mail. In additive manufacturing transport costs will be merely those of sending the specification electronically from the originator to a recipient firm's 3D printer and the costs of materials to a recipient firm. This will surely result in a huge drop in the cost of transporting certain types of goods (not all).

There are those who claim that this will lower all costs of production, including labor and capital costs. Indeed the labor cost in additive manufacturing may be very small: a primary labor cost will be those involved in devising and implementing the software protocols for shipment to 3-D printers.

Implications for Sustainable Growth and the Economics of Scale

The implications for sustainable growth are fairly obvious. Additive manufacturing will help:

- Conserve energy
- Reduce waste
- Reduce pressure on reserves of scarce non-renewable resources over time

Economics students learn all about economies of scale in introductory Microeconomics courses. Prior to 2014, if one needed a single wrench for changing tires, the manufacturer would first have had to make a mold, and then pour in the metal. To do this for one wrench would be outrageously expensive. But if the firm produces hundreds of thousands of these wrenches, it can pull down the costs with economics of scale.

But, with the 3D printer, even one item can be very cheap once the firm has a fully developed 3D printing process. To order a customized hip implant (one of a kind) one merely tweaks the software for hip implants generally and sends it along. It matters little whether one or 1001 of the implants are made. The cost may be low but will not decline much with numbers produced.

The implications for international trade could be very significant. Some traditional manufacturing firms in many countries, large and small, will go out of business. But the big question for emerging nations is:

How will countries with low wage cost be able to compete in trade when additive manufacturing is widespread? How could developed countries still use high import tariffs to protect local industry in such a world? Could trade sanctions such as those recently directed at Iran in 2014 work at all in such a world?

There are other surprising implications of additive manufacturing. Some researchers are already using 3-D printers to produce simple human tissue, such as skin, muscle and short blood vessels (this is called bio-printing). Food can be produced too. Cornell scientists have already produced printed cupcakes. Are printed hot dogs and pizza next?

The simplest objects can be made on a printer costing less than $10,000. Printers for more complicated products cost nearly upward of $500 thousand or more in 2013, but prices of these, like prices of computers generally, are declining.

When might this technology mature, such that it materially changes supply management, manufacturing generally, and international trade?

Perhaps by about 2020. Fast-paced technological change is already underway from discoveries already made (not those to be made in the future). This is happening in information technology, nanotechnology and biotechnology and the convergence of these fields. In any case, the implications of additive manufacturing for low and middle income emerging nations seem, on balance, ambiguous. Up to now, they have been able to capitalize on low wages for unskilled labor. But new technology could destroy millions of such jobs around the world.

In earlier technological revolutions, the revolution itself also created many millions of jobs. But now, more than ever, a nation's capability for capitalizing on this technology depends critically on its investment in human capital.

The compelling arguments for programs of investment in human capital are not at all confined merely to the need to cope with the labor-saving implications of additive manufacturing in particular, or digital displacement generally.

Far-reaching technological changes are flowing from new innovations in nanotechnology and biotechnology, and even more importantly, the convergence of these two technologies with information technology (see later sections of this module).

All countries, especially emerging nations, will need to stay abreast of these technological innovations both to partake in the abundant benefits that may flow from them and to avoid their negative consequences. To do this, it will require even heavier stress than before on fostering scientific and technological knowledge and know-how in 21st century programs for human capital formation.

We now turn to a discussion of these technological convergences.

Nanotechnology, Biotechnology, and Information Technology

The newest of these three fields dates only from the early 1990s, shortly after scientists at Rice University discovered a new form of carbon, called Carbon 60. Even by the year 2000, few people outside of research labs had ever heard of the new fields of nanoscale science and nanotechnology.

But by 2014 nanoparticles such as fullerenes, carbon nanotubes and graphene had become ubiquitous. They are found in sunscreens, clothing, hydrofracking fluids, in diagnostic tools in medicine, and, according to a new *Friends of the Earth* publication, in 94 food items consumed daily. These include cookies, doughnuts, milk, soy and almond beverages, as well as cereals, candy, crackers and sports drinks.

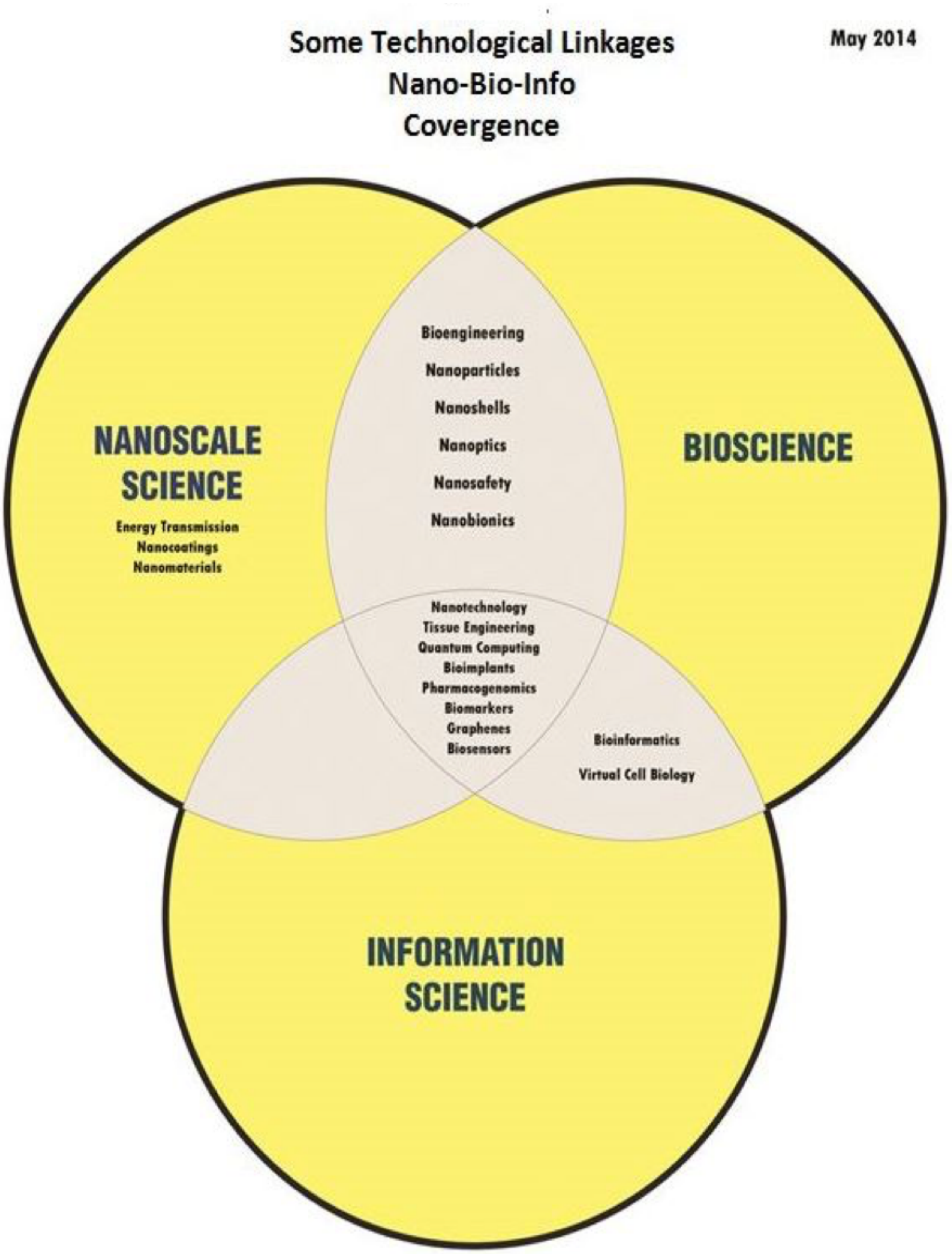
In any case, nanotechnology is one of three converging technologies that are materially changing how we live, how well we live, and how long we live.[footnote] The other two technologies are biotechnology and information technology. Jointly and separately, these three technologies are already bearing low-hanging fruit, especially in the energy industry and in biomedicine. Other potential benefits that may be ready to harvest in a decade or so. Still another group of blessings may accrue in 50 years or more.

Malcolm Gillis, *Perspectives on 21st Century Technology: The Nano-BIO-Info Convergence*. Prepared for the 10th Annual Rhodes Conference, Greece, October 3-8, 2012.

Nanotechnology operates in the realm of the incredibly small. It involves the measurement, manipulation and fabrication of objects in size from one nanometer to about 100 nanometers, a nanometer being one billionth of a meter. Your thumb is about 10 million nanometers wide. As we will see, the size and shape of nano-particles account for a large number of their highly useful applications. One particularly important property is that in the nanoworld, as we move to the nanoscale, the surface area of material increases relative to volume. Also at the nanoscale, soft material can become ultra-strong. Insulators can be made conductive. Opaque materials can become transparent. Eventually nanoscientists expect that they will be able to manipulate the inner workings of several kinds of molecules, yielding applications not yet imagined.

Biotechnology enfolds innovations in biomedicine, agriculture, and now even in information technology. It has become tightly interlaced both with nanotechnology and information technology generally. The information technology revolution that brought the age of computing now promises to combine with nanotechnology to yield another new age of quantum computing.

The effects of convergence of these technologies will be far-reaching, with potential social and economic benefits that are very, very large. However, these technologies especially nanotechnology also carry future societal risks and perils, as little is yet known about the implications of some nanoparticles for human health and the environment. [footnote]
For a discussion of the health and environment risk involved in nanotechnology, see Malcolm Gillis, “Health and Environmental Implications in Commercialization of Nanotechnology,” prepared for the 10th Annual Rhodes Conference, Greece, 2012.



The emerging coalescence of biotechnology, nanotechnology and information technology holds out prospects for economic and social benefits that could make those of the past half century appear pale by comparison (see Figure 1). This claim does not refer to breakthroughs that may be made “one day,” but rather applications from the science we already know, the fruits of discoveries already made.

Advances in molecular-level science furnish ample justification for this claim, not only in biology, but in nanoscale science and information science. To illustrate, consider one aspect of the Bio-Nano interface. Virtually all the molecular rungs on the chemical ladders of the human genome have been identified. So we now have an almost complete “parts list” for humans and some animals. Now, tissue engineering is furnishing parts of organs to replace damaged body parts.

There is another related revolution going on, at and below the molecular level, in information science and nanotechnology. This revolution capitalizes upon our growing understanding of the once forbidding world of quantum mechanics. This is enabling unexpected, rapid advances in quantum computing, which may endow laptops by 2025 with more computing power than millions of today’s super computers. The age of computing has been with us for only a quarter century. A new age of quantum computing may have begun in 2007, with the announcement of the world’s first practical quantum computer [footnote]
The Economist, (2007, February 17), “Quantum Computing: The world’s first practical quantum computer is unveiled”

The biomedical implications of the ongoing marriage of computational sciences and nanotechnology are especially auspicious. In 25 years, powerful, ubiquitous microscopic computers may be used as implants as sensors to monitor our bodily systems, to forecast weather, etc.

Nanotechnology - Wet and Dry

Nanotechnology has been heavily hyped, with some excessive claims. Still, it seems safe to say in 2014 that never before in history has one technology been so filled with promise, nor so potentially powerful, nor has any technological revolution happened as quickly. At the nanoscale, the boundaries separating traditional scientific and engineering disciplines become blurred to the point of non-existence. Therefore nanotechnology draws on many fields: physics, chemistry, mathematics, biology, computer science, engineering and clinical science. Much of nanoscale science and its growing applications are situated on the borderline of the familiar world of classical physics and the spooky realm of quantum mechanics. To begin to understand the forbidding world of quantum mechanics, one must accept that a sub-atomic particle can be in two places at once: two electrons may establish a kind of telepathic link that transcends space and time. This is called quantum entanglement, long understood to apply in the inorganic world and now perhaps in biological systems.

Research focused on the nanoscale has uncovered new phenomenon that displays properties of matter never observed before the turn of the century. Consider that the properties of matter change when taken down to nanosize. If the material in aluminum can is reduced to 25 nanometer size it would become pyrophoric, and explode spontaneously. Another manifestation: quantum dots two nanometers wide have different properties than those six nanometers wide: the former glows in blue light, the latter shines in red.

Nanoscientists and/or nanotechnologists work in either “wet” or “dry” nanofields. The dry, waterless side points toward valuable applications in energy efficiency and materials science, owing to the fact that some forms of carbon nanotubes are far stronger than steel, at one-sixth the weight as conductive as copper by volume and much better by weight.[footnote] The “wet side” (discussed in greater detail below), centers on study of biological systems that exist in a water environment, such as human cells. And since everything that goes on in a human cell is nanotechnology, some go so far as to assert that most of 21st century biotechnology is a subset of wet nanotechnology.

I note in passing that there are some quite unusual applications on the dry side, including Nano-ice, invented in Iceland, appropriately enough, in 2001. The process uses nanoparticles that eliminate the airpockets so detrimental to conventional freezing techniques. As a bonus, Nano-ice uses 90% less refrigerant and 70% less power than today’s ice-making machines.

Generally, “dry-side” nanotechnology innovations and applications have been growing quite rapidly in the energy industry:

- Nanotechnology is being deployed to remove contaminants from the huge amounts of produced water that results from hydraulic fracturing of oil-bearing formations.

- Nanomaterials such as graphene oxide are available to treat produced water for radioactive contamination. This can occur when oil wells pierce uranium-bearing formations, such as the Chattanooga shale in the U.S.
- Scientists at Rice University have developed a nanoparticle that absorbs 100% of its weight in carbon, and can therefore be used for CO_2 capture.
- Another group of scientists at Rice University has developed a sponge made of carbon nanotubes to soak up oil spills, in cold or warm water. [footnote]
  See Hashim et. al. *Scientific Reports*, Vol. 2, Article #363, April 13, 2012
- Other nanotech applications already in use in the energy industry include the use of nano-coatings to sharply reduce corrosion in casings and pipes in oil and gas wells, as well as nanocoatings to strengthen downhole materials subject to very high temperature and very heavy stress. One scientist at Rice University is developing a nanocoating corrosion inhibitor that promises not only to be very effective, but also (at $3.50 per pound) inexpensive as well.
- Nanoscale proppants are already being used to improve recovery of oil and gas from wells where hydraulic fracturing has been utilized. Proppants literally “prop open” fissures in rock so that oil and gas may more readily flow. The proppants in this case are nano-sized ceramic spheres with special density properties.
- Important dry-side applications include “nanowires” for transmission and conservation of energy.

Composed of billions of carbon nanotubes, such nanowires are known as Armchair Quantum Wires (AQW). Research on this innovation has been underway for seven years, and is now attracting the attention of business enterprises in the U.S. and elsewhere.

The AQW resembles chicken wire all rolled up, but it is a high strength wire made from pure carbon. One AQW would be about one to two centimeters thick, consisting of billions of single-walled carbon nanotubes

(SWCNT), one of the members of a family of nanotubes measuring about two nanometers across.

Not only is the AQW stronger than steel, but at one-sixth the weight of steel it has up to ten times better tensile strength than other composite wires. Thus, it could support itself as a high-tension, high voltage cable.[footnote] Hartley and Medlock (2011).

Here are but a few of the implications:

- Potential savings in of the energy cost of electricity, as transmission losses due to resistance are reduced.
- Usage of nanowires could increase the efficacy of renewable energy sources:
    - For wind, it would help end the stranding of capacity because of insufficient transmission capacity.
    - Solar energy from deserts could now be profitably transmitted to large urban areas.

Other Recent Discoveries – Dry Side

New breakthroughs on the dry side of nanotechnology are reported each month. Four of these recent discoveries are illustrative of some of the potential of this technology.

1. *Strain Paint and Self-Healing Paint*
   Of the many other potential applications of carbon nanotubes in energy, construction materials, clothing and body armor, one of the most fascinating is “strain paint” that can reveal weakness in metal structures. In 2012, researchers at University of Strathclyde, in Scotland, and Rice University, in Houston, developed carbon nanotube paint that can identify microscopic faults arising from stress or fatigue in materials in buildings, bridges and aircraft. The Rice version of strain paint is a varnish like substance which displays fluorescence in infrared light. Each nanotube in the paint would undergo equivalent

strain as the surface is painted. A handheld infrared spectrometer reads out the degree of strain in the structure.

A related application is self-healing paint. Nanomaterials have been developed for use as self-healing coatings for metals. Also, nanomaterials are being used as anti-barnacle coatings for ships hulls, with obvious implications for ship speed and energy conservation.

2. *Nanofibers*
   Nanoparticles are already in widespread use in the clothing industry, for example to repel water and prevent stains. Now, a small amount of nanotube sheets has been developed that can be used to produce porous multifunctional yarns that are weavable, flexible and durable, and which also allow energy storage. This technology may be utilized to make yarns of superconductors, lithium-ion battery materials and catalytic nanofibers for fuel cells. [footnote]
   Science, (2011, January 7).
3. *Nanomaterials with Viscoelastic Properties*

   A. **High Temperature Rubber**
      One of the remarkable properties of carbon nanotubes is their viscoelastic behavior over a wide temperature range. [footnote] An example of a viscous item is honey. Viscoelasticity, among other properties, enables a material to dissipate energy, and also reversibly deform through elasticity (like a rubber band). Viscoelasticity is what allows polymer foam earplugs to adapt to any ear channel. Several other types of materials, such as amorphous polymers and a few metallic alloys exhibit viscoelasticity.

      Materials made from carbon nanotubes display a very special type of viscoelasticity. Unlike rubber, which deforms permanently under very high temperatures, a mixture of several types of nanotubes (SWNT, DWNT, TWNT) yields a material that can recover its original shape after exposure to a very wide range of temperatures (as high as 1400°C for some mixtures and 300°C for others).

These nanotube rubbers may soon be incorporated in such uses as wrinkle-free textiles, viscoelastic shoes and even in space vehicles that are constantly exposed to a very wide range of temperatures.
Science, (2010, December 3)

B. **Viscoelasticity Sponges**
A scientist at Rice University developed a nanomaterial made of carbon nanotubes doped with boron that can be utilized as a super-absorber of oil spills. The sponge repels water, but strongly attracts oil. It has an important property that makes it useful in Artic as well as warm waters it displays temperature invariant viscoelasticity. Even in Artic waters the oil can be easily extracted from the sponge, which can then be reused. [footnote]
See Daniel P. Hashim et. al. (2012, April 13), *Scientific Reports*, 2(363).

4. *Graphenes*
Andre Geim and Konstantin Novoselov of Manchester University were awarded the 2010 Nobel Prize in physics for their 2004 ground-breaking experiments on the electrical properties of graphene, a carbon material that has the thickness of *one* atom. In the past eight years, the properties of graphene have been utilized to make possible major advances not only in electronic but other technologies as well. [footnote] A very important property of graphene is its two-dimensional nature. Because of this property, electrons in graphene travel through it *as if* they had no mass (much like photons).

Graphene exhibits unusual and sometimes antithetical or even paradoxical behavior. It is flexible like rubber but stronger than diamonds. It is transparent like glass but conducts electricity better than metal. New potential uses of graphene are announced almost monthly. It is already utilized in touch screens. Researchers at IBM have made ultrafast transistors from graphene. Graphenes may prove useful in sequencing DNA.

We will consider other graphene applications below.
Science, (2010, October 8)

Biotechnology and the Bio-Nano Interface

Tomorrow's biomedicine holds out the promise of benefits that were inconceivable a few decades ago. More than six decades have passed since James Watson and Francis Crick discovered the double helix in 1953. Since then, advances in genomics and related sciences and in information technology have transformed biology from a discipline centering upon the passive study of life to one allowing the active alteration of life, almost at will.

We have seen that the "wet" side of nanotech centers on the study of biological systems that exist in a water environment, such as human cells. Almost monthly scientists are finding new applications for three groups of nano materials: Carbon 60 (the buckyball), nanotubes and graphenes.

The biomedical uses of Carbon 60, the first fullerene, stem from its special properties.

Nobel laureate Rick Smalley of Rice University called the fullerene "God's molecule" because of its amazing and useful properties. Fullerenes are very, very small – about one nanometer wide. Their surfaces are thought to be particularly well suited for attaching therapeutic compounds. One promising anti-AIDS application capitalizes on three features of Carbon 60: its very small size, its ability to carry chemicals to deliver drugs to specifically targeted sites, and its unique shape that facilitates binding with cells infected with HIV.

Graphene could lead to the development of major new advances in biomedicine. For example, it has been recently developed in a wide variety of shapes, sizes, ribbons, platelets etc. and chemical modifications. [footnote] However, important questions as to the interactions of graphenes with tissues, cells and proteins remained to be answered, especially since different forms of graphene can produce vastly different results when studied biologically. [footnote]

Kostas Kostarelos and Kostya S. Novoselov (2014, April 18), "Exploring the Interface of Graphene and Biology, *Science*, 344(6181):261-263.

Ibid.

Graphene, however, is not a fiber but is flat and therefore does not share the same health risks that may be associated with another nanoparticle, the carbon nanotube.

The increasingly ubiquitous carbon nanotube also holds out great promise in biomedicine, especially where it does not interact with living tissue. Nanowires made of nanotubes can be employed to detect infinitesimally small concentrations of pathogens. In California, nanotechnology is being used to sniff out infinitesimally small concentrations of protein leaking from cancer cells. In 2008, a group of scientists in N.Y. developed a virus-eating nanoparticle that could, among other things, neutralize the virus in Avian flu.

Also promising are efforts underway at Rice and nearby M.D. Anderson Cancer Center involving other types of nanoparticles: gold nanoshells. These are biocompatible devices with a gold surface adhered to a silica core. At about 100 nanometers in diameter, they easily pass through the circulatory system. The optical properties of nanoshells may prove extremely useful in both diagnosis and treatment. They are treated with a fluorescent dye inserted into the body, and delivered to sites of individual tumors by virtue of antibodies attached to them. They are struck by a harmless near-infrared light and heated up to 55 centigrade, enough to destroy cancer cells, while leaving healthy cells unharmed.

A very serious problem in chemotherapy cancer treatment has been that in injections of even the most potent anti-cancer drugs, very few of the drug molecules hit their target – perhaps 1 in 100,000. Some are filtered out by the liver, others by blood vessels. As a result, the drugs have to be administered in very high doses, often with devastating side effects from toxicity. But scientists in the Houston Alliance for Nanohealth are now devising 3 stage nanorockets to deliver efficiently drug particles efficiently and in far greater numbers to tumors with far fewer side effects. This is a rifle shot on cancer rather than a shotgun blast.[footnote]
The 3-stage nanocarrier is injected into the bloodstream. The first stage seeks out the abnormal blood vessels around a tumor. As the first stage degrades, it releases the second: nanoparticles that burrow through the vessel to open a pathway for the medication to kill the cancer cells.

Other approaches to efficacious drug delivery using nanotechnology have been the development of nano-bubbles by clinicians at Houston's M.D. Anderson Cancer Center together with faculty at Rice University and Baylor College of Medicine. This process uses light-gathering nanoparticles to transform laser energy into plasmonic nano-bubbles. [footnote]
M.D. Anderson, Bulletin (2012, April 16)

This approach delivers cancer drugs or other therapeutic cargo at the level of the single cell. Researchers have found that delivering very strong chemotherapy drugs with nano-bubbles was up to 30 times more deadly to cancer cells than traditional drug treatment. Also, the treatment required one tenth the clinical dose, thereby reducing harmful side effects.[footnote]
See the following papers:
Biomaterials. 2012 Jul; 33(21):5441-50. Epub 2012 Apr 20. "Cell-specific transmembrane injection of molecular cargo with gold nanoparticle-generated transient plasmonic nanobubbles," Lukianova-Hleb EY, Wagner DS, Brenner MK, Lapotko DO. Source: Department of Biochemistry and Cell Biology, Rice University, Houston, TX 77005, USA.
Biomaterials. 2012 Feb; 33(6):1821-6. Epub 2011 Dec 2. "Plasmonic nanobubble-enhanced endosomal escape processes for selective and guided intracellular delivery of chemotherapy to drug-resistant cancer cells," Lukianova-Hleb EY, Belyanin A, Kashinath S, Wu X, Lapotko DO. Source: Department of Biochemistry and Cell Biology, Rice University, Houston, TX 77005, USA.
Journal Article *Advanced Materials* (impact factor: 8.38). 03/2012; 24(28):3831-7. DOI:10.1002/adma.201103550 "Plasmonic nanobubbles enhance efficacy and selectivity of chemotherapy against drug-resistant cancer cells," Ekaterina Y Lukianova-Hleb, Xiaoyang Ren, Joseph A Zasadzinski, Xiangwei Wu, Dmitri O Lapotko. Source: Department of Biochemistry and Cell Biology, Rice University, Houston, TX 77005, USA.

Finally, conventional wisdom has long held that quantum entanglements did not apply to biological systems. But recent research now suggests that entanglement may be essential for the vital biological process of photosynthesis [footnote] Also, birds are apparently endowed with a magnetism sensitive molecule that serves as a compass. Last year, researchers found that within that molecule, electrons remain entangled 10

to 100 times longer than the formulas of physics predict, [footnote] So, entanglement seems to be present also in large, warm systems including living organisms. Could entanglement then become a major focus in biomedicine? [footnote]
See Mohan Sarovar, Akihito Ishizaki, et. al, (2010), “Quantum Entanglement in Photosynthetic Light-Harvesting Complexes”, *Nature Physics*, 6, 462-467
Scientific American, November 2009.
See also Erik M. Gauger, Elisabeth Rieper, et. al, (2011, January 25), “Sustained Quantum Coherence and Entanglement in the Avian Compass,” *Physical Review Letters*, 106(4).

Nanobionics: Plant biology and Nanotechnology

New fields of inquiry based on Nanotechnology emerge regularly today. One of these is “Nanobionics.” Researchers at MIT in Cambridge, Massachusetts have imbedded carbon nanotubes in chloroplasts, that part of a plant’s cell where photosynthesis takes place. Some of the altered plants showed a 30% increase in photosynthetic activity. Other altered plants were able to detect small traces of pollutants in the air. Nanobionics will very likely lead to wholly new departures in the study and applications of plant biology.

Wet Nanotechnology: A Nanoparticle Trojan Horse

We noted that nanorockets are one approach to problem of debilitating side effects of very high doses in cancer chemotherapy where the drugs are as toxic to healthy cells as well as cancer cells. Another is a nanoparticle developed at Caltech [footnote] that effectively tricks tumor cells into allowing toxins to penetrate cell walls and only then release the cancer toxins to kill the cancer. The nanoparticles are doped with a drug toxic to cancer (paclitaxel) and used to ferry the toxin to the cancer cell. Nanoparticles are able to accomplish this, because they can be designed to optimize multiple functions:

- To destroy cancer cells
- To be soluble in water in order be transported by the circulatory system

- To be able to target the tumor cells and neutralize the cancer cell's defenses
- To shield normal cells from the toxin being delivered

Science, Oct. 15, 2010

This treatment is in the middle of clinical trials, and is but one of almost a dozen clinical trials of nanoparticle drugs in the U.S., while more than 50 companies are developing nanoparticle-based drugs to diagnose and treat cancer. [footnote]
Ibid.

Other innovations arising from wet nanotechnology include adding nanocoatings called Anhydide to de-icing agents, with obvious application in operations of airlines.

The Biotechnology-Information Technology Interface

Increasingly, scientific terminology from computer science is entering the vocabulary of life scientists. And, research on computers made from biological components is now well advanced. This is understandable, since in their own ways, biological cells display computational and communicative attributes. Instead of software, we might call this the "wetware" of molecular biology. In any case, it is clear that biology is increasingly becoming an information science. Both fields deal with information processing. In the case of IT, the information is electronic. In the case of biology, biochemical information is processed. Decoding the human genome would have been impossible without the advanced computational technology now at our disposal. You might visualize your genes as your own customized software, containing recipes, or codes, for complex proteins that tell the cells in your body what to do, and how and when to do it.

And consider the amazing properties of the human chromosome. Each cell contains in the cell nucleus 46 strands of the double helix. If the strands in just one cell nucleus could be uncoiled, they would together measure 1.8 meters. A truly massive amount of information can be encoded along this length. The human genome project revealed at least 30 thousand genes and at least 300,000 proteins. The recently concluded ENCODE project, discussed below, reveals much more. To more fully understand how all these genes work together requires computing capacity far beyond what was thought possible even a decade ago. The rapid increase in the speed, and the extraordinary fall in costs of analyzing genomic data has made mathematical, statistical and computer methods the handmaiden of advances in biomedical research, diagnosis and therapy. And when quantum computing becomes cost-effective, the implications for biotechnology could open up heretofore unknown horizons.

Another fruitful implication in the bio-info interface is found in computational cancer research. Cancer is not a hundred different diseases, but rather many thousands of different diseases. At least five mutations may be required to create a cancer cell, each drawn from a repertoire of as many as several hundred genes. So, there are an overwhelming number of possible combinations and permutations of cancer-causing mutations and they vary according to individuals' genetic and epigenetic endowments. To illustrate, a group at Cornell University has created devices that rapidly identify mutations that cause tumors, thereby allowing more targeted, individualized therapies. Elsewhere, Israeli scientists in 2008 developed a DNA computer. This biological computer under certain conditions could release cancer-fighting drugs.

Also, our growing understanding of how human cells communicate with one another has led to totally new perspectives on cancer. Researchers in Cambridge, Massachusetts have found that stroma, or non-cancer cells that host tumors, have a continuous dialogue with cancer cells inside the tumor. The signals they send may cause cancer cells to become more aggressive and then metastasize.

New approaches at the intersection of biotechnology and information technology also have wide applicability to the mainstay of 20th century biotechnology: new pharmaceutical products. For the 21st century, the difference will be that more and more pharmaceutical innovations will be IT based. Consider for example the new field of pharmacogenomics, which will allow the customization and personalization of much of medical treatments, eventually replacing traditional therapy based on the outmoded premise that “one drug fits all.”

Pharmacogenomics deals with the genetic basis underlying variable drug response in different individuals. It also relies on the study of sequence variations in genes thought to affect drug response: It looks at the entire genome, enabling not only the identification of variant genes governing different drug responses across patients, but also those genes that affect susceptibility to disease, allowing new insights into disease prevention as well as enhancing prospects for individualized applications of drug therapy.

The potential for truly revolutionary work in the bio-info space has been greatly magnified by the September 2012 announcement of the results of the multi-year $180 million project called ENCODE. Previously, scientists believed that 22,000 genes underpin the “blueprint of human biology.” But these 20,000 were only 20% of the human genome. ENCODE examines the other 80%, and came to the startling conclusion that what was once believed to be “junk DNA” is not only biochemically active, but contains about 40,000 regulators to help activate or silence genes. ENCODE results provide insights that will lead to new ways to diagnose and treat diseases.

The Nano-Info Interface

The graphene revolution accelerated in the late 1990s after Andre Geim and Konstantin Novoselov found a way to transfer ultra-thin flakes of graphene from scotch tape to a silicon wafer. Since then, graphene research has flowered greatly, not only on both sides of the Atlantic, but in Asia as well. Samsung alone holds at least 200 patents in graphenes.

Whereas carbon 60 (the buckyball) and carbon nanotubes are three dimensional nanoparticles, graphene is a two-dimensional substance of pure carbon. Graphenes possess very unusual electronic and optical properties. And according to Nobel Laureate Novoselov, graphene is “the strongest, most flexible, most stretchable, most conductive material, and also is optically transparent.”

Until recently, graphene was described as the strongest material that could ever be made – about 100 times stronger than steel by weight and of equal thickness. However, research in 2014 by Jan Lou of Rice University suggests that graphene may be more brittle than previously thought. The slightest defect in a graphene ribbon notably reduces its strength. However, methods are under development to assure a very high degree of purity in the ribbons.

Notwithstanding this apparently temporary problem, the potential applications of graphenes range from desalinization of seawater, to lightweight and strong composite materials in aircraft, autos and satellites, and anti-rust applications. Also, it now appears that graphenes can be used to detect Parkinson’s disease, ordinarily very difficult to diagnose, and in the cleanup of nuclear accidents.

A mere recitation of recent published research on graphene would require many more pages then would fit in this book.

Here is a partial list just in the nano-info interface:

- Thin elongated strips of graphene with straight edges gradually transform from semi-conductors to semi-metals as their width increases. These are called graphene nanoribbons. Tour et al. in 2009 demonstrated how longitudinal “unzipping” of carbon nanotubes could cheaply generate graphene nanoribbons for electronic applications.
- Leavendorf et al. in 2012 have shown how graphene layers can be peeled off of growth substances and transferred to various platforms for atomically thin circuitry.
- In 2013, Ye et al. described a method for making graphene quantum dots from coal. The dots range in size from 2 to 20 nanometers.
- Geo et al in 2013 reported methods for batch processing of graphene in a semiconductor production line. This may allow accelerated technological applications of graphene in electronics as well as other fields.
- In 2012, El-Kady et al. used lasers to reduce graphite oxide films to graphene that can be used directly as electrodes. Devices made with these electrodes display ultrahigh energy density values and

mechanical properties, with potential applications in high-power flexible electronics.
- Naritu et al. in 2013 demonstrated how graphene nanoribbons (GNRs) are excellent candidates for next-generation electronic materials. These graphene nanoribbons may prove useful for the development of GNR-based nanoelectronics.
- Finally, nanoscientists have shown they can rapidly produce large quantities of graphene using a variety of methods. Feng et al. (2013) do so by an electrochemical technique using organic salts and an electric current.[footnote] And, at Rice University, Professor James Tour and his colleagues have noted that most of the carbon sources used in large-scale production of graphenes are expensive purified chemicals. They have developed a much less expensive approach that uses six readily available carbon containing materials such as cookies, chocolate, grass, plastic, roaches, and even dog feces.
  Feng et al. (2013)

The Grand Interface: Nano-Bio-Info

Consider that in 1970 the fabrication of a single transistor cost about 10 cents. The first Intel computer chip had 2300 transistors. This chip used 10,000 nanometer wide technology. The latest Intel Xeon processor (2014) uses 22 nanometer technology. These developments are driving down rapidly the costs of storage capacities and sequencing. In 1982 with the Intel 80386 chip, $1 bought several thousand transistors. By 2012, when chips contained as many as a billion transistors, $1 would buy 20 million transistors. Among other miracles, this has drastically reduced the cost of sequencing genes: less than a penny a pair. I leave it to you to imagine the future implications for preventative medicine.

The marriage of nano-bio and info technology is making deep inroads in detection and diagnosis of cancer, cardiac disease and severe traumatic injury. Researchers at Rice, M.D. Anderson and UTHSC have devised an inexpensive diagnostic nano-bio-info chip that promises to be quite effective in detecting both malignant and pre-malignant oral cancer and other diseases. With the chip, invasive, painful biopsies are not needed.

Results are ready on the spot rather than days later, and the cost is affordable.

This chip is one of the growing number of biomarkers under development in nanomedicine. At present it is also being tested to detect heart attacks by analyzing saliva, with heartening results thus far. The chip works by deciphering body fluids such as saliva and blood to reveal unique chemical and biological constituents, and changes in them.

Tissue engineering, a field born less than 2 decades ago, is an excellent example of the grand interface. Traditional biomedical engineering used metals, polymers and ceramics to construct temporary or permanent replacements of body parts that interact minimally with surrounding tissue. I have one of those in my foot. These replacement parts often promote infections, wear out, or loosen with time. Tissue engineers take exactly the opposite approach: they design biologically active materials that interact extensively with adjacent tissues in order to facilitate the regeneration process. Blending materials and concepts from nanotechnology and information technology into biotechnology, the new field has begun to yield products for repair of damaged tissue. Skin for burn patients is already available from first generation tissue engineering. Tissue engineering more generally promises to allow fabrication of a range of spare human parts to replace diseased or spent ones, or even to improve functions of healthy tissue. Tissue engineering targets include bone, cartilage, blood substitutes and eventually a variety of organ replacements.

Already, scientists at Wake Forest University have grown gall bladders on artificial “scaffolds” of water soluble material. Seven patients have these new bladders, and they are still working. [footnote] While physicians in Europe have implanted lab-grown tracheas. In Japan several children are living with tissue-engineered cardiac blood vessels. [footnote]
The Economist, (2010, February 20).
Science, (2011, August).

The second generation of tissue engineering is already upon us. Progress in rebuilding complex organs such as lungs will be difficult, but is no longer the stuff of science fiction. Tissue engineers, harnessing properties of intercellular communication, have even begun to induce in vivo heart

muscle regeneration. If they are successful, it may be possible to generate muscle for a “cardiac muscle patch.” [footnote]
Science, (2010, February 12).

One new innovation in tissue engineering marries nanowires with human cells. In September 2012, scientists from Harvard, MIT and other Boston-area universities announced the creation of Cyborg-like tissue, where a network of nanowires containing electrodes will enable physicians to monitor changes in human tissue at levels not imagined before.

The third generation of tissue engineering is almost at hand. By 2020, engineers might deploy self-assembling nano-electronic components to create 3-D circuits to improve the tissue compatibility of implants. Especially promising are plans to print organs using inkjet technology to imprint stem cells. Scientists and engineers are adapting tissue engineering to deal with a multitude of medical problems such as kidney failure, atherosclerosis, spinal cord injuries, inflammations, age-related diseases, and osteoporosis. It now seems that there are only a few parts of the body that cannot be ultimately replaced with bio-artificial replications of body parts.

Conclusion: The Nano-Bio-Info Convergence

Nanotechnology will surely revolutionize energy and materials science. The potential for truly staggering applications of biotechnology as augmented by nano and information technology is also in little doubt. However, whether much of this potential will be soon realized is yet unclear. Financial constraints on transfer of innovations based on these technologies are loosening, but legal and regulatory constraints loom much larger than in past technological revolutions. In the U.S. the Food and Drug Administration has become increasingly risk-adverse in approving new genetic and nanotech treatments in medicine; and no one knows what the next session of Congress will bring.

From genomics, biotechnology has already provided us with a complete parts list for humans. As a result of advances in wet nanotechnology and information technology, tissue engineering promises to provide widely available, inexpensive, and reliable spare parts for humans. If we can find ways to resolve ethical – and perhaps moral – issues raised by our fast-expanding capacities in these converging technologies, their economic and social impacts could be as profound and as positive as that wrought by any previous revolution in human history.

Even ten years ago, much of what we have discussed today seemed impossible. What can we say about that? We may close with a pithy quote from Arthur C. Clarke, the writer who first envisioned the idea of artificial earth satellites: "The only way to discover the limits to the possible is to venture a little past them – to the impossible."

Developing nations who hope to successfully cope with the potential challenges arising from 21st century technology will clearly need to focus very strongly on programs of education and research that steadily enhances and expands the stock of human capital.

INSTITUTIONS (INTANGIBLE CAPITAL)

Introduction

The study of the role of Institutions in economic growth and development seems to have passed through three distinct phases in the last century. The first was in the heyday of such high-profile “Institutionalists” as Thorstein Veblen.[footnote] The appeal of approach was sufficiently such that the Harvard Economics Department brought Veblen to Cambridge[footnote] in 1910 to be considered for a faculty position, which he then spurned. For the next six decades after Veblen, economists focusing on institutions as both cause and effect of development were few and far between, isolated in small pockets in universities across the nation.
See Thorstein Veblen, (1899), *Theory of the Leisure Class: The Economic Study of Institutions*, New York, NY: Macmillan.
See Edward S. Mason & Thomas S. Lamont, (1982, August), “The Harvard Department of Economics from the Beginning to World War II,” *The Quarterly Journal of Economics*, 97(3): 383-433.

The third, present, phase began in the late 20th century with the work of Nobel Laureate Douglas North[footnote] and then blossomed with the appearance of significant contributions by younger economists, especially in and around Cambridge, Massachusetts, who once again made the study of the rule of institutions in economic processes not only respectable, but impossible to ignore.
Douglas C. North (1990), *Institutions, Institutional Change and Economic Performance*, New York, NY: Cambridge University Press.

Prominent among this group has been Daron Acemoglu of MIT,[footnote] Simon Johnson of MIT, and James Robinson at Berkeley,[footnote] all of whom are concerned with how prosperity and poverty are determined or affected by institutions and the incentives they create. Other major contributors have been Dani Rodrik at Harvard[footnote] and William Easterly at NYU,[footnote] among many more.
See, for example; Daron Acemoglu, Simon Johnson & James Robinson, “Institutions as the Fundamental Cause of Long-Run Growth”, Cambridge, MA: NBER Working Paper #10481, May 2004.

See Daren Acemoglu & James A. Robinson, (2012), *Why Nations Fail*, New York, NY: Crown Publishing Group.
Of his several publications on this topic, see especially “Institutions for High-Quality Growth”, Cambridge, MA: NBER Working Paper #7540, February 2000.
William Easterly, (2008, May), “Design and Reform of Institutions in LDCs and Transition Economies: Institutions: Top Down or Bottom Up?” *The American Economic Review*, 98(2): 95-99.

These and other authors have presented persuasive arguments for including institutions along with technology, physical capital, human capital and natural capital. There has been useful controversy over the question, “do good institutions cause growth, or are they the results of investment in human capital and pro-growth government policies."[footnote] These authors and others have identified a number of institutional arrangements most relevant for progress, or poverty.
See Edward L. Glaser, Rafael La Porta, Florencio Lopez-de-Silane & Andrei Schleifer, “Do Institutions Cause Growth”, Cambridge, MA: NBER Working Paper #10568, June 2004.

Some of the questions that flow from the more recent work on institutions include:

- Is the press free, largely free or suppressed?
- Can I enter a business easily, without coping with entry restricting prohibitions or large license fees?[footnote]
  Licensing Restrictions played a major role in the stagnation of the Greek economy in the first decade and a half of the 21st century.
- Are these government-protected monopolies or oligopolies that stifle commerce?
- Does weak governance make costs of corruption high?
- Are tax rates enforced, and/or are they even enforceable?

The literature on the role of institutions had become very rich and very sizeable by 2014. A short module in a collection of works such as this one cannot begin to do justice to the insights to be gained from this literature. That said, we now proceed to examine some of the most salient points of this growing body of work for the economics of development.

We begin by noting that for decades, economists and aid agencies urged poor countries to "get their policies right." First and foremost what they really meant was to get their "prices" right. They were mainly referring to "macro prices," such as:

- The price of money (interest rate)
- The price of foreign exchange (exchange rate)
- The prices of agricultural products (reduce subsidies)

This was part of the so-called Washington Consensus in the 1980s and early 1990s, well described elsewhere.[footnote]
See Dwight H. Perkins, Stephen Radelet & David L. Lindauer (2006), *Economics of Development*, New York, NY: W.W. Norton, Chapter 5: 179-181.

However, getting policies right is only a necessary condition for initiating sustaining economic growth; it is far from a sufficient condition.

This was clearly evident from experiences in 1990s in Poland and Russia. Advised by Professor Jeff Sachs, both countries attempted reforms aimed at "getting prices right," but the efforts were generally unsuccessful.

Why? The remedies offered ignored institutions and institutional weaknesses, especially problems of governance.

Rule of Law

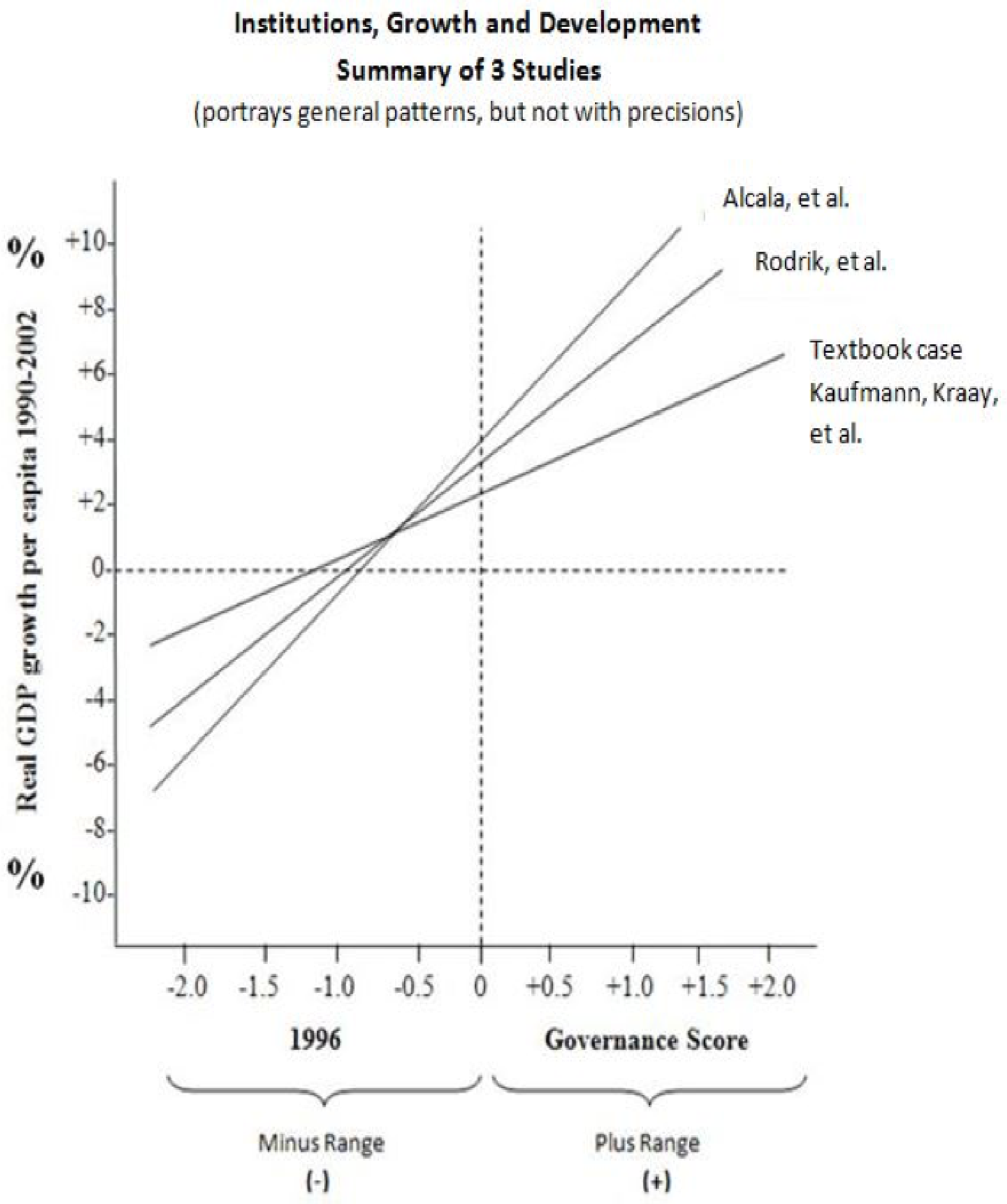
There are many definitions of the "Rule of Law". Basically the rule refers to how well important institutions function, institutions such as property rights, contract enforcement, stability in governance, even-handed governance (in the public and private sectors), accountability in governance, the quality of bureaucracies and much else.

It is helpful to examine three studies of more than 75 nations by Kaufmann and Kraay,[footnote] Rodrik and others,[footnote] and Alcalà and Ciccone. These studies relate GDP per person to estimates of high or low degrees Rule of Law. All these studies find a clear association between six dimensions of governance (including the Rule of Law) and economic growth (See Figure 1). Together, the six dimensions are called the "governance score".[footnote]

D. Kaufmann, A. Kraay & M. Mastruzzi, "Governance Matters III: Indicators for 1996-2002", Washington, DC: The World Bank, Policy Research Working Paper #3106, 2003.

Dani Rodrik, Arvind Subramanian & Francesco Trebbi, "Institutions Rule: The Primacy of Institutions over Geography and Integration in Economic Development, Cambrdge, MA: NBER Working Paper #9305, November 2002.

The "governance score" depicted in Figure 1 summarizes these six dimensions". (1) Press Freedom (Voice and Accountability), (2) Political Stability, (3) Government Effectiveness, (4) Quality of the Regulatory Climate, (5) the Rule of Law, and (6) Limits on Corruption in both public and private sector.



Each of the six dimensions is important. But perhaps the most significant is that of property rights.[footnote]

For a similar view, see Daron Acemoglu, Simon Johnson & James Robinson, (2001, December), "The Colonial Origins of Comparative Development: An Empirical Investigation", *The American Economic Review*, 91(5): 1369-1401.

We will return time and again to the property rights issue when we discuss sustainable development. For now, it suffices to say that in developing nations the evolution of property rights, especially in land, since 1945 can be divided into two distinct periods.

First Period, 1945-1982: A period of centralization of property rights in the hands of government, beginning in the years noted below.

Europe	1945
China	1949
Indonesia	1948
Much of Africa, esp. Ghana	1968
Cuba	1959

Second Period, Since 1980: A gradual move away from centralized property rights in land, with governments reluctantly relinquishing rights to either local groups or individuals.

Consider China. Beginning in 1982 the situation on property rights have been evolving. General statements about this evolution are difficult to make, but China is clearly moving away from Marxist principles regarding property rights, wherein land rights were owned only by the government.

Other examples include four Western Hemisphere nations where there has been a process of return of property rights of land to indigenous people. These are:

- Colombia (1982)

- Peru (1998)
- Brazil (2008)
- Canada (since 2006)

In British Columbia, the first nation people (Amerindians) have traditionally held their land in common. Now several tribes, such as the Nisga'a and Tsawwassen, are granting private property rights in land to their members. Leaders of their tribes say that lack of well defined, tradable property rights has been the biggest obstacle to economic development. Now, with individual rights in the land, it can be used as collateral on loans, to get mortgages, or to start up businesses.

While many sub-Saharan African nations are now growing faster, African nations are still among the poorest in the world because they have had weak, ineffective institutions. They have ineffective institutions largely, but not wholly, because of the legacy of colonialism.

How did this happen? Studies by Daron Acemoglu at Harvard explain part of it as the legacy of malaria and yellow fever in earlier colonial times (1600-1900). Malaria and yellow fever meant high mortality rates for the colonial imperialists: British, French, Dutch and Belgian settlers in Africa and Asia. To illustrate, the largest graveyard in Accra, Ghana contains many examples of colonial governors who died within 4 or 5 years after arrival in Ghana.

The high mortality rate affected the institutions the European imposed on their colonies. High death rates caused the imperialists to prefer institutions that favored easy extraction of such natural resources as tin, gold, diamonds, and cocoa. These are called extractive societies.

Another example: Indonesia from 1700-1940. Young men from Holland went there in pursuit of their fortunes. After a few years, they returned to Holland to build sumptuous houses. Under these conditions settlers opted for weak protection of property rights and very limited checks on government power.

Where the death rates for colonists were very low, as in Jamaica, Aruba, Bahamas, Bermuda, and South Africa the imperialists opted for stronger protection for property rights and more stable institutions.

Institutions have interacted with economic development in countless interesting ways throughout history. Consider an example from Southeast Asia.

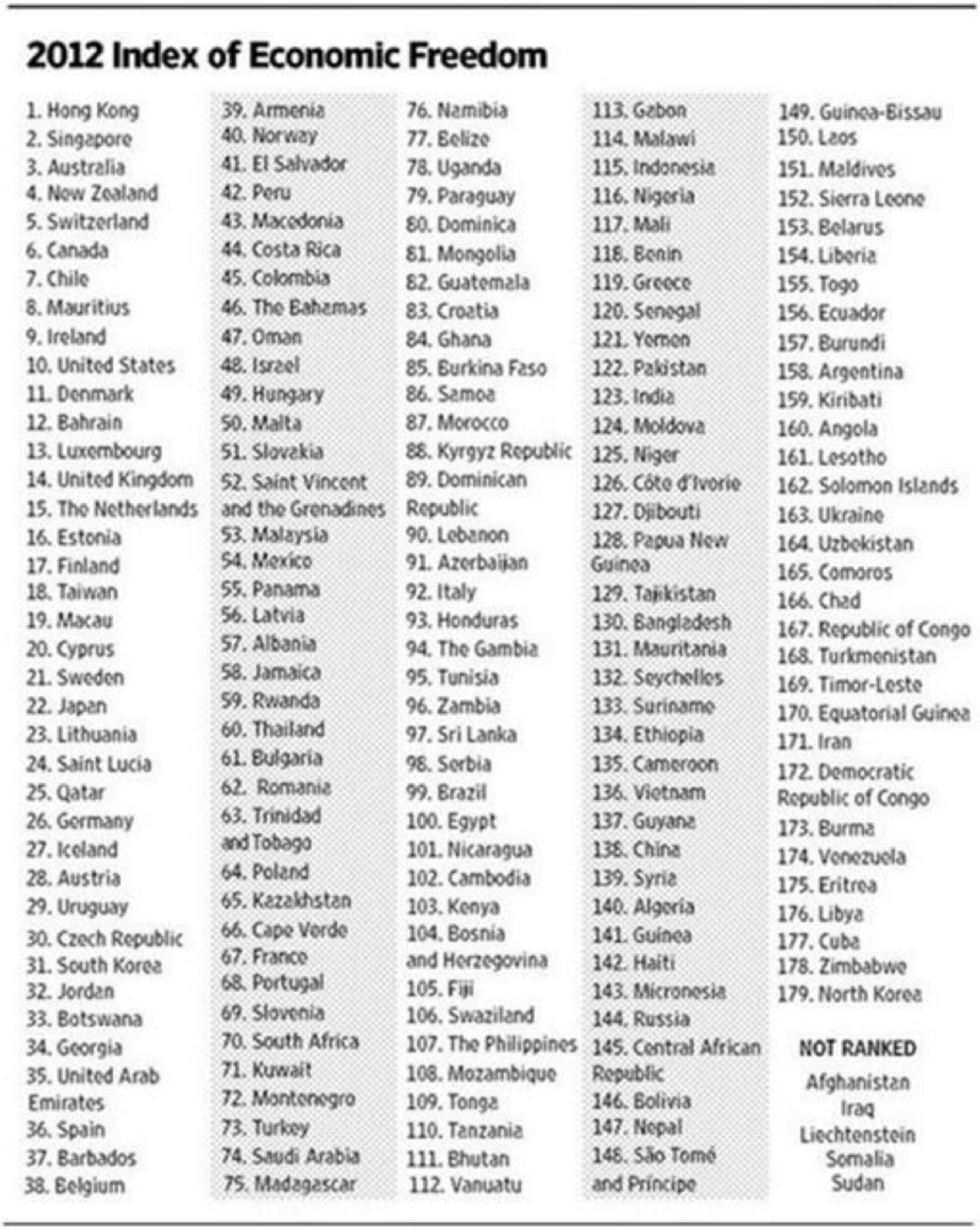
The Minangkabau of West Sumatra in Indonesia are a proud, industrious people. For centuries, the Minangs were fully matriarchal. This was also a society featuring the rare marriage institution called Polyandry. Under Polyandry wives had multiple husbands. This institution had a major impact on Indonesian development under Dutch colonial rule (1609-1946). Minang men were called the Lebanese of Indonesia. (Overseas Lebanese are famous for their entrepreneurship all over Africa and Asia.) Minang males could be found in all parts of Indonesia – Java, Borneo as well as Sumatra, starting businesses and importing foreign technology. What made Minang males so prominent in entrepreneurship all over Indonesia? Consider: what do husbands do in a Polyandrous society? A male who is one of three men married to a Minang women has plenty of time on his hands, and little to keep him at home. So, Minang males would be absent from West Sumatra for long periods. The wife's other husbands were there to handle husbandly duties.

Many Minang husbands in their wanderings seized opportunities for business: in trade, agriculture, commerce, and fishing all over the country. They were, in fact, the strongest native entrepreneurial group in Indonesia until very recent times. (But Minangs were never as dominant in trade as were the Chinese minority in Indonesia.)

Many informal institutions have evolved over centuries and are very important to society. A good example is Gotong-royong in Indonesia, especially East Java. The phrase means literally, "we work together". This institution defines rules for social collaboration, literally cooperation, on such vital matters as irrigation where the entire adult community participates. The ease of operating local irrigation system in Java contrasts sharply with those in much of rural India, where irrigation questions were very difficult to resolve.

For the last several years, an index of economic freedom covering 179 countries has been published by The Heritage Foundation and The Wall Street Journal (see Figure 2). Two East Asian nation-states—Hong Kong and Singapore—top the list (see Figure 2). Australia and New Zealand rank third and fourth. The United States, surprisingly to many, stands at number 10 on the list. The lowest ranked developed nation is Greece at 119. The four nations with the lowest indices of economic freedom are Libya, Cuba, Zimbabwe and, at position 179, North Korea.

To conclude, then, economic freedom clearly depends on institutional arrangements, because institutions ultimately determine the degree of freedom or of oppression in any given nation.



2012 Index of Economic Freedom

1. Hong Kong
2. Singapore
3. Australia
4. New Zealand
5. Switzerland
6. Canada
7. Chile
8. Mauritius
9. Ireland
10. United States
11. Denmark
12. Bahrain
13. Luxembourg
14. United Kingdom
15. The Netherlands
16. Estonia
17. Finland
18. Taiwan
19. Macau
20. Cyprus
21. Sweden
22. Japan
23. Lithuania
24. Saint Lucia
25. Qatar
26. Germany
27. Iceland
28. Austria
29. Uruguay
30. Czech Republic
31. South Korea
32. Jordan
33. Botswana
34. Georgia
35. United Arab Emirates
36. Spain
37. Barbados
38. Belgium
39. Armenia
40. Norway
41. El Salvador
42. Peru
43. Macedonia
44. Costa Rica
45. Colombia
46. The Bahamas
47. Oman
48. Israel
49. Hungary
50. Malta
51. Slovakia
52. Saint Vincent and the Grenadines
53. Malaysia
54. Mexico
55. Panama
56. Latvia
57. Albania
58. Jamaica
59. Rwanda
60. Thailand
61. Bulgaria
62. Romania
63. Trinidad and Tobago
64. Poland
65. Kazakhstan
66. Cape Verde
67. France
68. Portugal
69. Slovenia
70. South Africa
71. Kuwait
72. Montenegro
73. Turkey
74. Saudi Arabia
75. Madagascar
76. Namibia
77. Belize
78. Uganda
79. Paraguay
80. Dominica
81. Mongolia
82. Guatemala
83. Croatia
84. Ghana
85. Burkina Faso
86. Samoa
87. Morocco
88. Kyrgyz Republic
89. Dominican Republic
90. Lebanon
91. Azerbaijan
92. Italy
93. Honduras
94. The Gambia
95. Tunisia
96. Zambia
97. Sri Lanka
98. Serbia
99. Brazil
100. Egypt
101. Nicaragua
102. Cambodia
103. Kenya
104. Bosnia and Herzegovina
105. Fiji
106. Swaziland
107. The Philippines
108. Mozambique
109. Tonga
110. Tanzania
111. Bhutan
112. Vanuatu
113. Gabon
114. Malawi
115. Indonesia
116. Nigeria
117. Mali
118. Benin
119. Greece
120. Senegal
121. Yemen
122. Pakistan
123. India
124. Moldova
125. Niger
126. Côte d'Ivorie
127. Djibouti
128. Papua New Guinea
129. Tajikistan
130. Bangladesh
131. Mauritania
132. Seychelles
133. Suriname
134. Ethiopia
135. Cameroon
136. Vietnam
137. Guyana
138. China
139. Syria
140. Algeria
141. Guinea
142. Haiti
143. Micronesia
144. Russia
145. Central African Republic
146. Bolivia
147. Nepal
148. São Tomé and Príncipe
149. Guinea-Bissau
150. Laos
151. Maldives
152. Sierra Leone
153. Belarus
154. Liberia
155. Togo
156. Ecuador
157. Burundi
158. Argentina
159. Kiribati
160. Angola
161. Lesotho
162. Solomon Islands
163. Ukraine
164. Uzbekistan
165. Comoros
166. Chad
167. Republic of Congo
168. Turkmenistan
169. Timor-Leste
170. Equatorial Guinea
171. Iran
172. Democratic Republic of Congo
173. Burma
174. Venezuela
175. Eritrea
176. Libya
177. Cuba
178. Zimbabwe
179. North Korea

NOT RANKED

Afghanistan
Iraq
Liechtenstein
Somalia
Sudan

Source: Wall Street Journal, Jan. 12, 2012

CORROSION OF INSTITUTIONS: RENT-SEEKING

Rent-seeking

This topic sheds some light on why there are around the world such pervasive pressures for inefficiency, for failing to minimize costs.

The term rent-seeking was first introduced by a then young economist, Professor Ann Krueger. The phrase has become a part of the daily vocabulary of economics.

There has been long concern with rent-seeking across cultures. An example from Spanish literature would be Los Interes Creados ("The Special Interests").

Professor Krueger had a long-held concern about the costs of rent-seeking. Three decades ago, she made an extremely useful contribution based on her work in the U.S. and in Turkey. She integrated elements of international trade theory with the economic theory of bureaucracy and the systematic study of economic policy-making. The result was a seminal article titled "The Political Economy of the Rent-Seeking Society." It is assigned reading in my Economics of Development course.

This contribution changed the way economists look at the workings of government, at influence-peddling, corruption, and just ordinary bureaucratic ineffectiveness. It gave us a systematic way of studying issues related to corruption rather than relying on anecdotes.

Her framework, in the hands of later scholars, has enhanced our understanding of determinants of resource allocation and income distribution. We will see that rent-seeking behavior has implications that are rarely positive either for efficiency or equity, except by accident. Her framework deals with efforts by government officials, lobbyists, traders, and managers to secure favorable treatment from government officials. These favors result in "rents," which go to the wealthiest, thereby worsening income distribution.

The theory shows how rent-seeking activities divert energies and resources from productive activities, thereby stunting economic growth and skewing the rewards from economic activity. Rent-seeking is thus a corrosive activity in any economy.

That is to say, successful rent-seeking activities have been one of the major factors accounting for maldistribution of income. This was long true, especially in Latin America.

The rent-seeking framework is also useful for analysis problems in the U.S., Canada and Europe. Is really useful for looking at 21st century Russia, the “Kleptocratic Society.”

The estimated losses for rent-seeking behavior in U.S. are less than 3% of GDP.

The effects of rent-seeking behavior are almost always very corrosive to economies and societies. When rent-seeking behavior interacts with structural problems of an economy, such as overdependence on oil revenue (Nigeria), the results can be spectacularly toxic.

In Turkey for example, there was an import-licensing system in seventies. Import licenses awarded to political favorites. It cost 15% of the GNP.

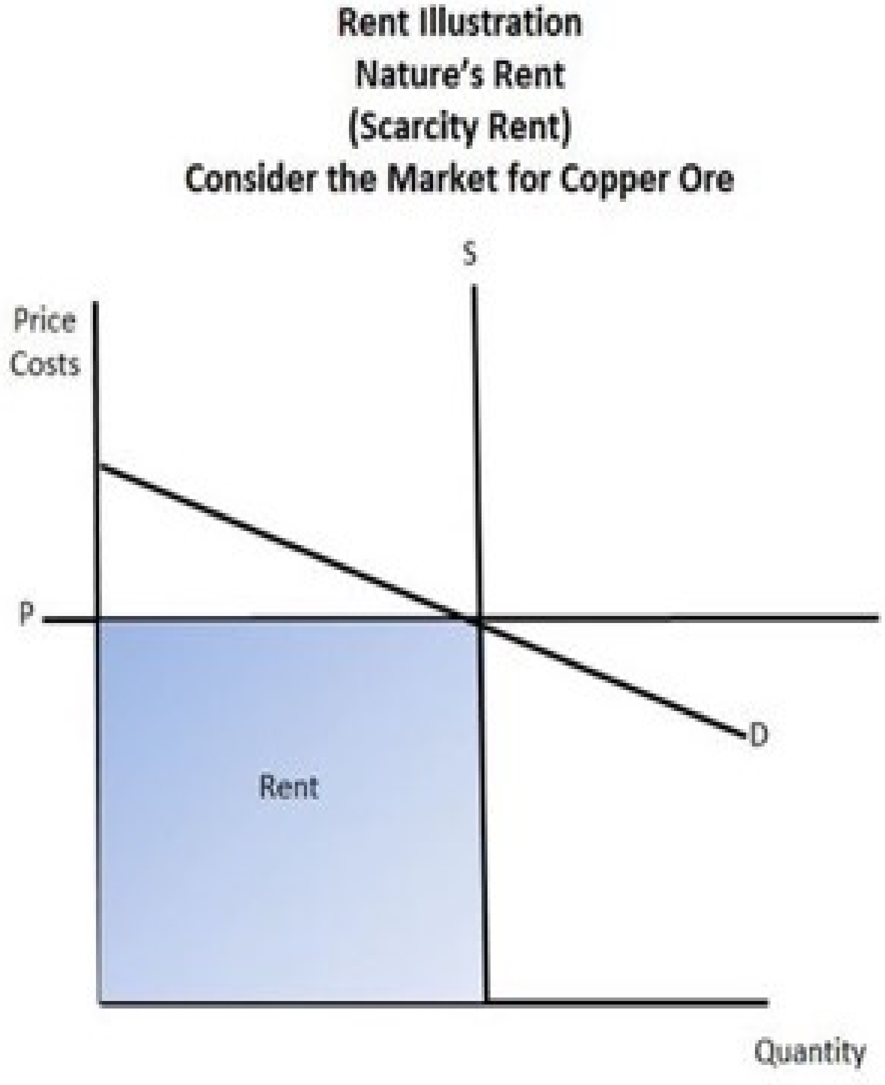
To understand the consequences of rent-seeking behavior, you need to understand what is meant by the term “rent” in economics. We noted earlier it has several meanings. Let us investigate. We must distinguish always between “natural rents” and artificial, “unnatural rents.”

The concept of natural rent, or resource rent, will be an important consideration when we discuss natural resources and sustainability.

1. The Nature of Rent and The Rent of Nature (resource rents) Rent is a honored concept in economic analysis. It dates from David Ricardo (1772-1823). Ricardo fought the British protectionistic corn laws for 30 years. In 1815 Ricardo asked: "Why is the price of corn high? Is it because rent on the land is high?" No: Corn is not high because rent is high; rent is paid because the price of corn is high. Rent is price

determined, not price determining.

Rent defined: Most generally, a resource rent is a return in excess of a resource owner’s opportunity cost. For capital, a rent is any return in excess of the “normal” return to capital. “Natural rent can include both “Nature’s Rent” (see below) and “Quasi-Rent.”


Rent Illustration
Nature’s Rent
(Scarcity Rent)
Consider the Market for Copper Ore

2. Nature’s Rent (Scarcity Rent) is an important concept in sustainable development. Natural resource rents are also called insitu rents. This is an excess return due to the inelastic supply of natural resources (inelastic supply in the short-to-medium term). But in the long-run, not even natural resources are in very inelastic supply, unless they have no substitutes at all.

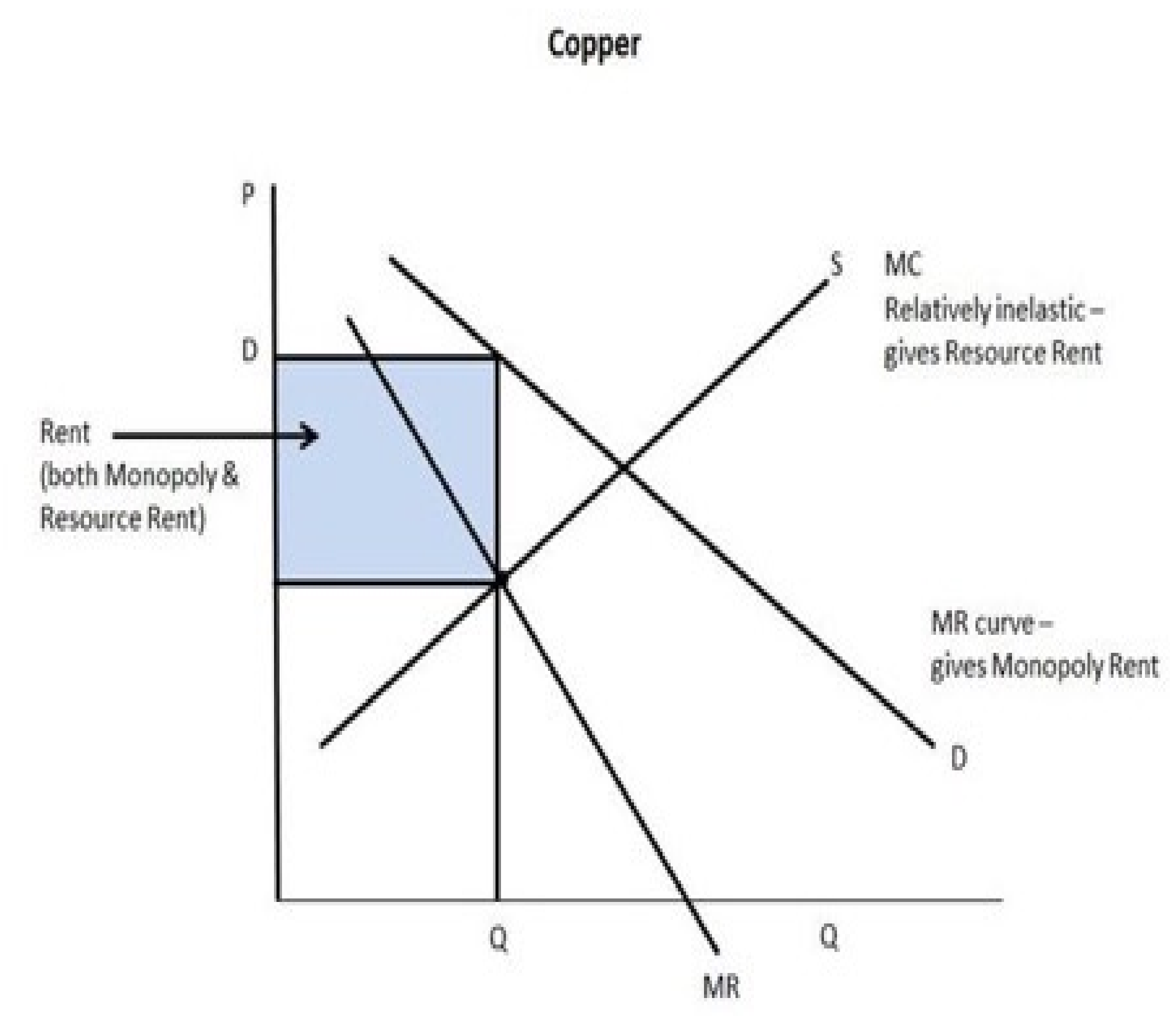
But, over time, even natural resources such as copper or lithium are not in inelastic supply. Several things cause supply elasticity to increase over time, even for natural resources. What are they?

First, higher prices make old, abandoned deposits or previously inaccessible deposits profitable to exploit. Changes in technology such as the advent of horizontal drilling of oil and gas (to be discussed below) makes many older or previously unattractive discoveries yield much higher returns. This is especially true in the oil and gas industries, where technological changes combined horizontal drilling with fracturing of sub-soils. This, in turn, results in a much higher recovery from existing deposits.

So even with hydrocarbons and minerals, long run supply curves tend to flatten out toward the horizontal.

Also note that in many natural resource industries, rent is a mixture of monopoly or oligopoly rent and natural resource rent.

Consider the international copper industry. This is not a competitive, but an oligopolistic market.



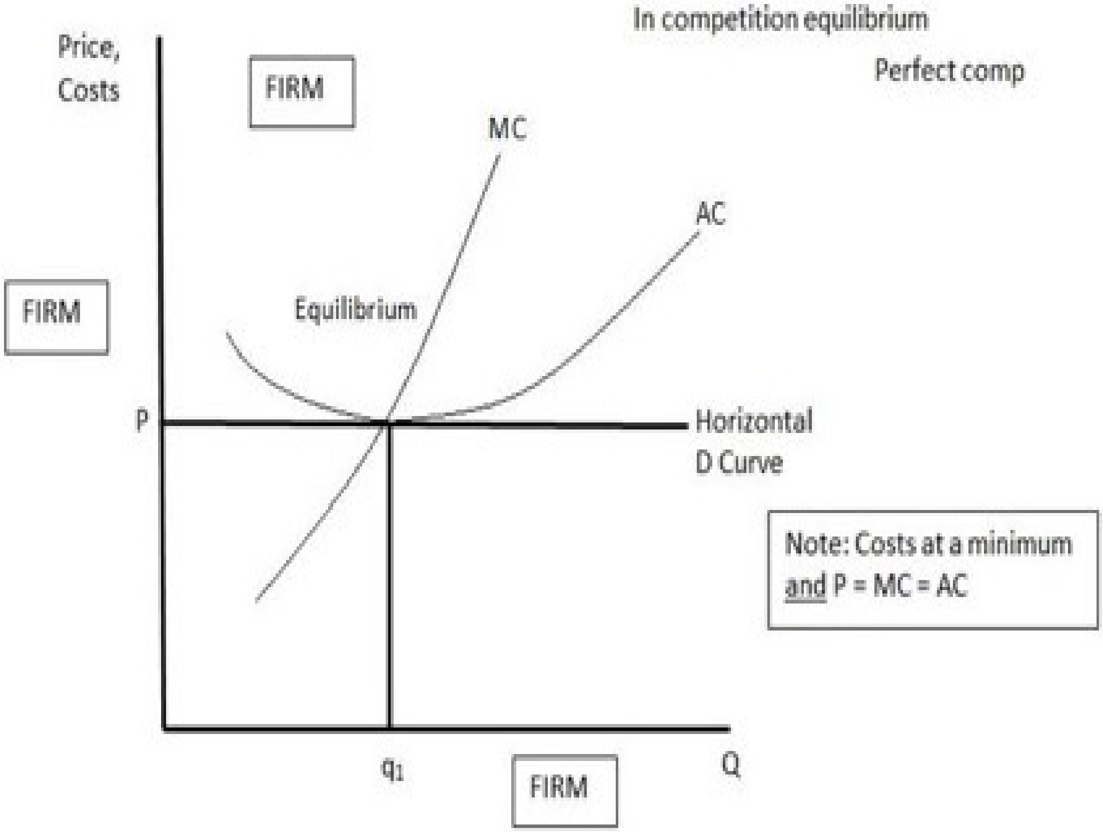
Again: basically, a rent is any return in excess of the “normal” return to capital including Human Capital. We define “normal return” below. A rent may be very temporary, in which case we call it a quasi-rent. Rents may accrue to ownership in natural resources, in which case we call it a natural resource rent. (Note: rents should not be confused with risk premia. What are risk premia? Compensation to investors for accepting unusual risk.)

All windfall gains are rents, but not all rents are windfall gains. A windfall gain is an unanticipated rent. We will not very much concerned with windfall gains, as they tend to be transitory, and from economist’s point of view, tend to be counterbalanced by windfall losses. A good example of a windfall gain is lottery winning.

Look again at definition of rent: any return in excess of the normal return to a factor of production, whether capital or labor or land.

Now, how can we define what is the “normal return to capital?” This is a very simple, important and often misunderstood aspect of economic theory.

Again consider what a cost curve means in economics, for example a long-term cost curve for a firm, in a perfectly competitive industry.



What costs are summarized by the AC curve?

Answer: Labor costs, material costs, land costs and a “normal” return to capital (perhaps 5.5% in 2012).

In the long run, a firm must cover all these costs, or it will go belly-up.

How do we define a “normal” return to capital?

The normal return to capital is the opportunity cost of capital. This is the minimum payment capital must receive to be supplied to a firm, or to an industry, or to the economy to prevent capital from going elsewhere.

Normal return, then, is what capital can earn in its alternate uses, combined with labor.

Another way of putting it: normal return to capital is an average return to investments in activities with “average” risks.

Note: Labor can receive rents too. For example, what is quarterback Peyton Manning’s opportunity cost (value in next best case use)? He might earn $200K as a banker. He earns at least $20 million per year in pro football. The excess of his football salary over his value in his next best use is rent.

Normal returns to capital are not necessarily constant over time. In fact, they can vary depending on economic conditions.

Example: Reduced national savings make capital scarcer, which tends to drive up the normal return to capital.

Increased demand for investment capital may also drive up capital’s normal return across the economy, and the world.

Again, in the long run, under assumptions of perfect competition, the return to all capital owners is just the normal return to capital. There are no permanent rents aside from natural resource rents, no economic profits.

How can this be?

Rents, or economic profits, are competed away. With free entry and exit of firms into all industries, this must happen, under competition.

Digression:

Note: I said earlier that in the U.S. average real returns to capital in recent years have been about 6%.

They were perhaps 8% in the mid-1990s, 7% in the late-1990s (dot.com boom), and about 5.5% in 2013.

Of course real returns to capital in emerging nations are higher. Why is that?

Partly because capital is scarcer there than in the U.S. However, international mobility of capital tends to make returns everywhere converge.

But also real returns to capital may be as much as 20% in even middle income emerging nations. This figure reflects two other things.

1. High risk premia that must be paid to capital because of greater economic and political risk due to institutional weakness in emerging nations.
2. Fairly pervasive monopoly profits (rents) owing to natural resources rents and government policies restricting competition in other fields.

Now come back to the diagram.

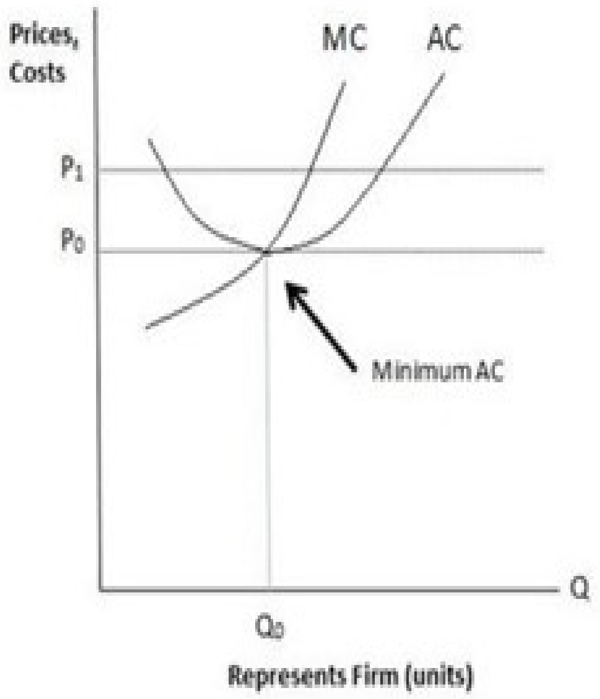
Consider again an industry under competition. Say the shoe industry. Let this be in the long run a constant cost industry.

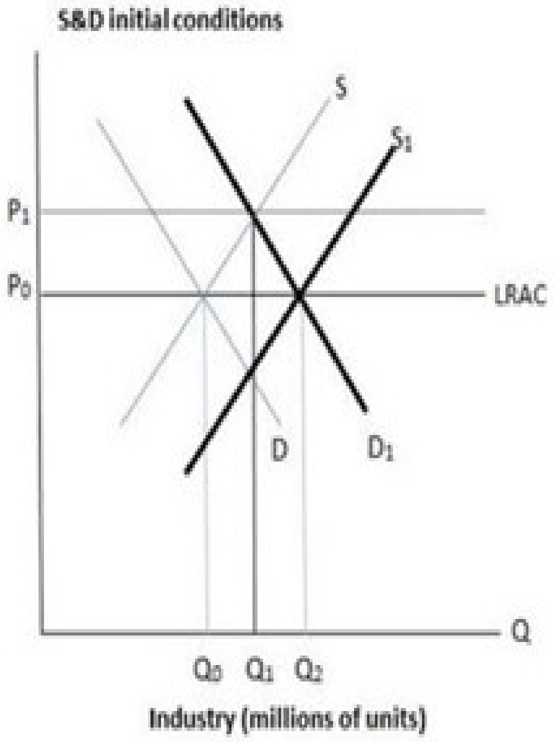
Again- what is a constant cost industry?

An industry that uses no specialized factors of production. So, expansion or contraction of output of that industry will itself have no effect on the prices it pays for its inputs.

Other things external to the industry, like inflation, may cause its cost to rise, but output changes in the industry itself will not affect its costs.

Consider shoe industry as a constant-cost industry, under perfect competition with free entry and exit of firms.





Industry in the long run equilibrium at a price P_o and $q = q_o$. All producers are just covering all costs, just earning a “normal” return. Now, let P_o P_1 because overall shoe D shifts to D_1. Now what?

For any producer, AC now less than price. There are temporary economic profits – capital owners getting a short-term rent. Returns to capital are temporarily in excess of normal return to capital (quasi-rent). Remember, AC includes normal return to capital.

What now happens?

With capital in this industry receiving excess returns, new firms will enter, attracted by returns greater than normal.

Then what happens?

Under perfect competition with free entry and exit of firms, supply shifts to the right. (S_1) Price falls back to P_0.

In equilibrium, all firms make no more than normal return. Also, P=MC=AC (minimum AC) for all producers. This is efficient. P=minimum AC. Nirvana for economists.

Now, over the centuries, people have found ways to thwart this process and receive contrived rents, or long-term returns in excess of “normal returns.”

The best way, or the oldest way, is to restrict competition.

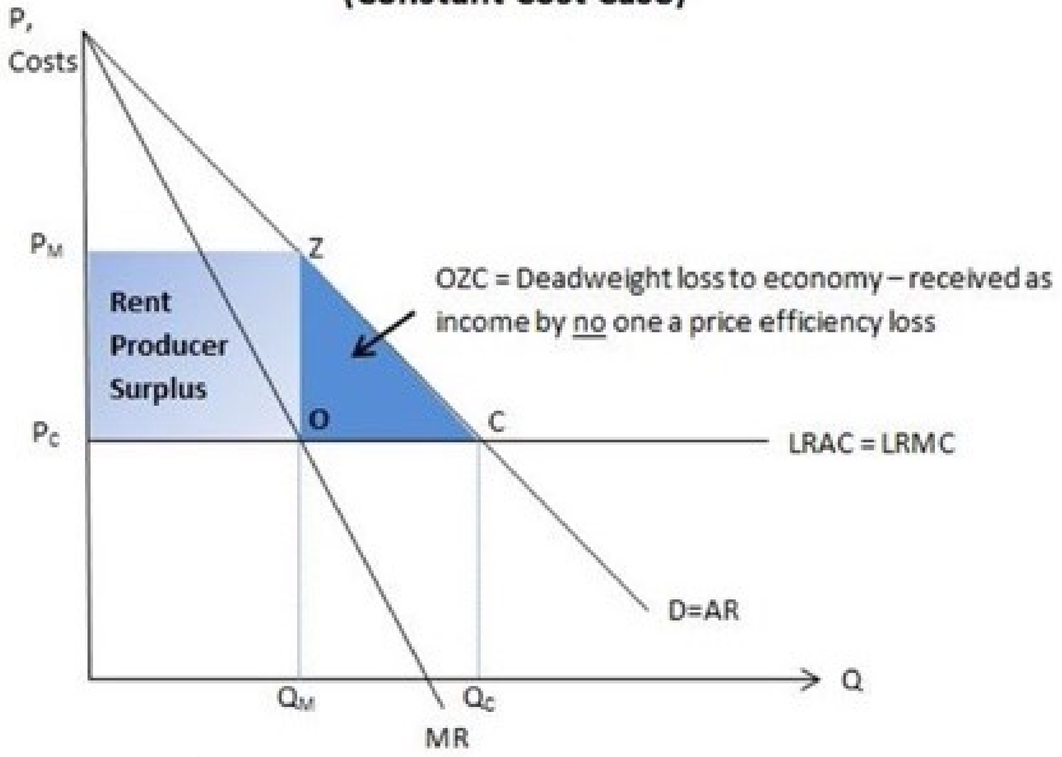
So, let us more closely examine monopoly or oligopoly rents from rent-seeking behavior: a clear symptom of allocative inefficiency.

How to get such monopoly rents? Secure a monopoly or oligopoly privileges, most often granted by government thru licensing franchises. Monopoly rent- can prevail even in the long run.

Consider the shoe industry. We saw earlier that the competitive solution is P = MC = AC, where AC at a minimum for all producers.

If the constant cost shoe industry were turned over to a monopolist, instead of a perfectly competitive outcome, then what would we have? Take a look:

Contrived Rent
Caused by Restricting Competition and/or Restricting Entry
Shoe Industry – as a Monopoly
(Constant Cost Case)



OZC = Deadweight loss to economy – received as income by no one a price efficiency loss

P_C = Price if industry perfectly competitive
P_M = Price under monopoly
Q_C = Quantity under competition
Q_M = Quantity under monopoly
P_COZP_M = Producer Surplus (Rent)
P_CCZP_M = Loss of Consumer surplus from monopolization
OZC = Deadweight loss (P_CCZP_M) minus (P_COZP_M)

Now LRAC is also LRMC? Why?

Because with horizontal AC, MC = AC.

And with a monopolist we have downward sloping D facing one producer, the monopolist.

Now the monopolist has an MR curve. Where will it be? It will have twice the slope of the AR curve (D curve).

Now profit maximizing monopolist does what? Equates MR and MC.

This will be at output level Q_m. Now D curve says that Q_m can be sold for P_m.

Now, the competitive solution would be Pc, Qc recall. Why?

The monopoly solution involves output restrictions: $Q_m < Q_c$

And Price $P_m > P_c$

Monopolization generates rents – these are contrived, or unnatural rents. Not like natural resource rents, or quasi-rents.

The monopolist now earns a return in excess of the normal return: $P_m > AC$

Per unit rent is distance OZ from A_R curve to AC curve. Overall rents are the total area (PmZ PcO).

Now, what would we have here is a very simple kind of rent. One example of a contrived rent. Rents are attractive right? People like to receive them. They seek them. But the presence of contrived rents indicates and introduces inefficiency in the system.

Why?

Consider again the triangle CZO in the monopoly diagram. This is deadweight loss, or economic waste, or inefficiency.

Why?

Consumers of shoes lose as a result of monopolization. They pay higher prices. This robs them of what we call consumer surplus.

In fact, consumers lost consumer surplus equal to the big trapezoid (P_m P_c ZC).

But, this is partly counterbalanced by the producer surplus received by the monopolist (rectangle) in the form of rents. (P_mZP_cO).

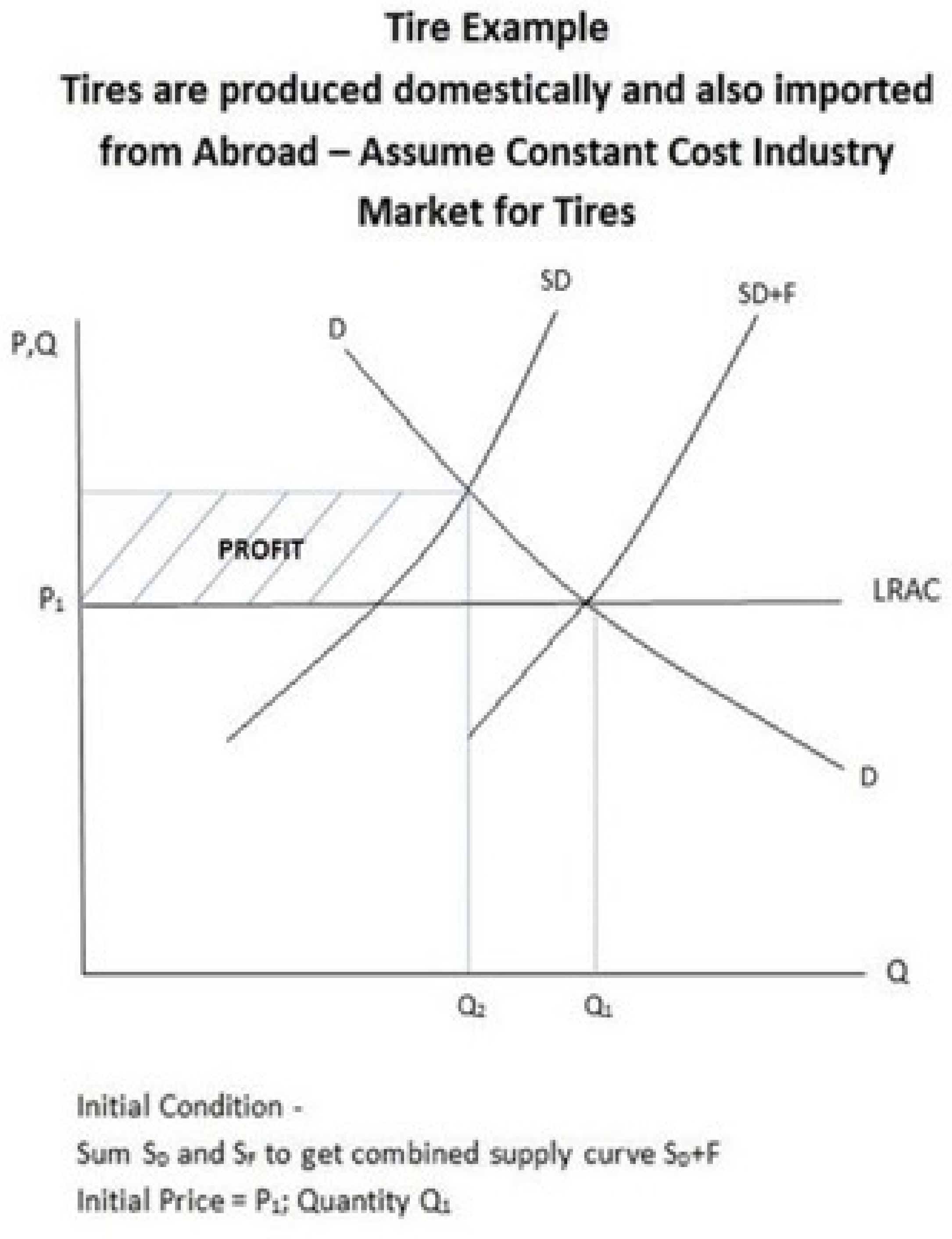
But part of the loss in consumer surplus is not received by the monopolist. The triangle (ZOC) is dead weight loss, or efficiency loss. These triangles are often called Harberger Triangles after Al Harberger of Chicago.

Now, what is the whole point of the rent-seeking literature, pioneered by Ann Kruger? The whole point is that when people seek to capture these rents, the result is not only this familiar kind of efficiency loss the deadweight loss, but another kind of loss as well. That is, in the process of seeking rents, people use up scarce resources in trying to secure rents, campaign contributions, or bribes to government officials. This creates waste, as people spend money on directly unproductive activities. (DUP) They compete for the privilege of seeking rents. They produce not, nor do they satisfy: their labors are barren. These activities are lucrative from the point of view of the individual rent-seeker, but not the economy as a whole.

Let’s try another example.

Suppose we consider the market for tires in a small country. Assume a constant cost industry, initially under perfect competition. Initially there are no import restrictions.

Consumers can buy domestic tires or foreign tires. The market for tires is as follows: total supply SD + F (Domestic Supply plus Imports).



Tire Example

Tires are produced domestically and also imported from Abroad – Assume Constant Cost Industry

Market for Tires

Initial Condition -

Sum S_D and S_F to get combined supply curve S_D+F

Initial Price = P_1; Quantity Q_1

Now, because of lobbying by a local tire producer, the government bans imported tires. Supply drops back to merely S_D. Government also decrees no more firms can enter the industry. Price rises to P2, Q falls to Q_2. Now there will be rents in the system for the tire producers. The rents caused by the import ban are indicated by rectangle P_2ABP_1, and the efficiency loss by the triangle (ABC). Since no new firms can enter, these rents are permanent. Owners of capital in the tire industry benefit at the expense of consumers of tires. Government gains nothing.

These kinds of output restrictions (like monopolies and import bans) have been common throughout the world, especially in poorer nations.

Examples:

> Monopolies granted to individuals:
> Indonesia- Flour, tires, cloves,
> Monopolies by government firms:
> Spirits (much of Latin America)
> Electricity
> Import Restrictions
> Fish in Ghana
> Pharmaceuticals in India, Indonesia
> Autos in Latin America, Indonesia

Then, there are more pernicious forms of rent-seeking. The vehicle that is used for this form of rent-seeking and has been a particular bane to some developing countries in Latin America, is the cartel. A cartel is little more than a group of collaborating firms seeking to increase their revenues by working together and thus eliminating competition. In Latin America this form of rent-seeking was once associated with the 1930-1995 international coffee cartel. The coffee cartel 1930-1995 was largely run by Brazil and Columbia. Recently cartels have been more closely associated with drug production and smuggling operations, as well as the associated rent-seeking activities of bribery and protection. These cartels, in their quest for greater profits, pose significant security risks for citizens in several Latin American states and threaten the very stability of several governments. In Mexico, for example, well over 12,903 people had been killed in drug-related violence during the first nine months of 2011, rendering certain parts of northwester Mexico substantially too dangerous for tourism [footnote] The economic impact of the Latin American cartel is therefore not just in its effect on the price of illicit narcotics, but for its effects the stability required for strong markets. This in turn damages other sectors of the economy not directly involved in the initial rent-seeking exercise. These include tourism and industry, where foreign investment is often of critical importance. The Mexican case also demonstrates how forms of rent-seeking often complement each other: in 2007 it was reported that several high-level anti-drug officials passed information to the cartels in exchange for millions of dollars in bribes.

When you study rent-seeking, a pattern emerges.

The prime route to unnatural rents is through supply restrictions. Again, I repeat, there are many kinds of supply restrictions.

- Monopolization (or Oligopolization)
- Import restrictions (tariffs, prohibition etc.)
- Import licenses (to control the volume and composition of imports)
- Licenses to enter a field (barbers, bakers, construction, etc.)
- Entry restrictions in an industry (no foreign owned firms allowed)

Now, if you are a rent-seeker, where do you go to obtain such restrictions?

Answer: Mostly to governments (Federal, State or Local).

"Politicians are like diapers. They need to be changed often – for the same reason." --Will Rogers

The rent-seeking literature maintains that governments are the main (not the only) source of non-natural rents. The claim is that government policies are responsible for most rents in most societies.

The aim of rent-seekers: convince the government to agree to one or another form of supply restriction.

Import controls are pervasive in both LDCs and DCs, but more so in LDCs. What kinds of imports controls? Again,

High tariffs
Quantitative restrictions (Quotas)

Prohibition of imports
Import Licenses (can’t import certain products without license from government)

So, if government dispenses the favors, and if these favors are eagerly sought, it is natural that people compete to get these favors: they spend money and other resources to secure continued rents.

Competition for rents conferred by government policy uses up scarce resources.

Example: Lobbying expenses: Consider the opportunity cost of using a $800 /hour lawyer hired to lobby for supply restrictions.

Corruption: A World-Wide Issue

In 19th century, corruption was as rife in the U.S. as anywhere in the world: municipal governments and robber barons kept finding new ways to steal from taxpayers and investors. Many things brought this corruption down to more manageable level. What was the most important factor? A free and independent press (see Corruption and Reform: Lessons from America's Economic History: Edward L. Glaeser and Claudia Goldin, University of Chicago Press).Even today, different states have different degrees of tolerance of forms of rent-seeking. High tolerance: Massachusetts, Illinois, Maryland, New Jersey. Low tolerance: Minnesota, California, Oregon and North Carolina. How is this explained? You tell me.

Consider the costs of bribery that may be involved in chasing unnatural rents. Consider economic costs of excess capacity resulting from rent-seeking. Rent seekers always justify such restrictions in the higher national interests rather than their own narrow self-interests.

Now, of course, you can secure supply restrictions without government. Private cartels in the U.S. and Europe in 1890-1940 (IG Farben) show this with regard to oil, diamonds, and sugar. Yet governments had a protective hand even in private cartels. But it is argued, the usual source of supply restriction is government, and is much easier to go to government to secure supply restrictions than by seeking collusion between private sector producers (why: cheating by private colluders is easier, and the sanctions on cheating are less severe.

> Cheating leads to an ineffective cartel
> OPEC – affects price thru supply restrictions
> However, the history of OPEC since 1970 shows many examples of cheating (not sticking to output restrictions)
> And it is, of course, true that supply restrictions are pervasive in LDCs. Governments often confer monopoly privileges on certain producers (Tires, beer, auto, etc.). Examples include Indonesia and Zambia

Rent-Seeking and the Greek Drama

A simple fact: Greece cannot afford the standard of living it enjoyed before 2010. There is but one important industry: tourism. Greece is in an economic vise now for 4 reasons:

1. Very generous social benefits granted by government, such as 35 hour weeks, retirement at 56 years, special bonuses each year to public workers (over monthly salary).
2. Greece cannot begin to collect the taxes they have on the books. The country has high tax rates, low collection, and much tax evasion (perhaps 50%).
   So, Greece is unable to pay for its large government expenses.
3. Very low growth since 2004. With low growth, few new jobs. Youth unemployment in 2013 was 50%. There is lower tax revenue, higher deficits, and growing national debt.
4. An extensive, stifling system of licensing, to enter business, to start tax companies, etc. Greece has been experiencing what Gulliver endured at the hands of the Lilliputians.[footnote]

> Yet Greece is not tied down by wires, but by the cumulative efforts of decades of rent-seeking behavior.
>
> Licenses are the fourth thing strangling the economy. To limit competition and benefit rent-seekers, Greeks have imposed stiff, onerous licensing requirements on almost every sector. You can hardly find a business or occupation to enter without first getting a license, if indeed the government will grant you one.
>
> And often they do not. To illustrate: trucking firms need a license to enter business of hauling freight etc. When was the last license issued? 1971. Nuff said.
>
> The European Union imposed tough austerity measures on Greece in 2011-12, to reduce high deficits and growing national debt. But austerity has not led to economic growth. Economic growth remains curtailed by the suffocating effects of the licensing system.
>
> Swift, Jonathan, Gulliver’s Travels, Ireland: Benjamin Motte, 1726.

In the 1970s, President Nixon’s oil price controls meant that we had an oil entitlement program for refineries, which drove up the price of fuels. Some refineries existed only because of the existence of oil price control.

Competition for favors dispensed by government is rational. It makes good sense for rent-seekers because the potential rewards are large.

Just how valuable are these favors to those who receive them? Consider again the U.S. entitlement program in oil - $75 billion went to 80 refineries in 1980. Consider another typical case: Indonesia in the 1990s. Before then, Indonesia imported polystyrene used in the manufacture of various plastic products. Then in 1994, a new local plant began making polystyrene. Initially they received a very low protective tariff of 5%, employed 115 workers (“infant industry” argument was used). This is the way protection usually begins.

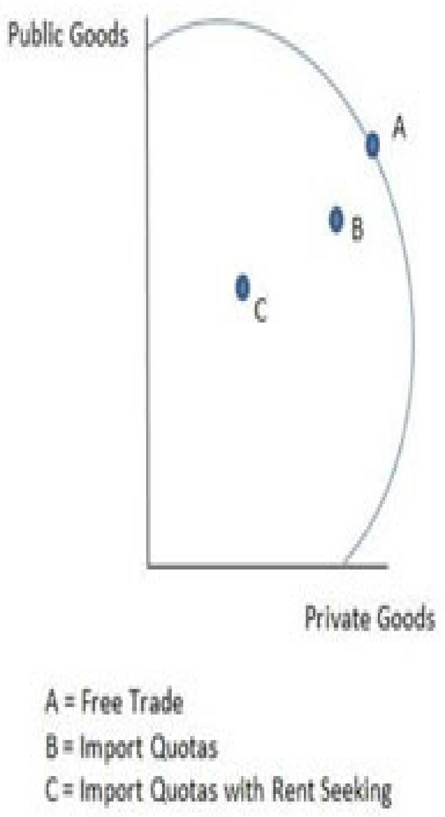
The owner of the plant soon demanded an increase in protective tariffs from 5%-20%. If granted, this subsidy would have resulted in large rents for the owners. In fact, the subsidy itself would have amounted to 171% of the firm’s total investment. Who would pay the costs of the subsidy? Indonesian consumers. The rate of return to the shareholders would be about 40% per year, given higher protection.

Are these rents worth competing for?

Yes.

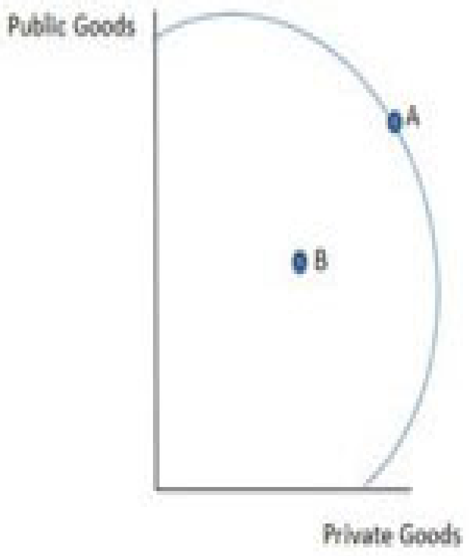
Consider estimates reported by Anne Kruger for Turkey and India. In both countries, rents to imports from import licenses alone were very sizable – annually: 7.5% of the GNP in India, 15% in Turkey. In the U.S., Richard Posner estimated the cost of rent-seeking in 1970 at 3% of GNP.

Anne Kruger argues that rent-seeking is not unlike any other kind of economic activity, such as production or distribution of goods. She plausibly argues that rent-seeking firms use up resources in rent-seeking activities just as they do in producing goods. By hiring “expediters” (brokers), lobbying, and in some cases by bribery.



A whole literature has developed to extend Kruger’s original work.

In her first contribution on the topic, she proceeded as follows. She used import restrictions as an example. She used a simple model to show how free trade can put a society on its P.P. curve, not within it.



She then showed how an import restriction reduces society’s welfare even without rent-seeking (because it leads to ordinary allocative efficiency losses) (Point B).

Then she showed (conceptually) how competitive rent-seeking, coupled with import restriction, reduces a society’s welfare by even more than in the case of the import restriction without rent-seeking.

In sum, she shows how rent-seeking activities result not just in transfer of economic welfare from one group to another, but also destruction of economic welfare, since it also affects resource allocation and causes needless waste.

And rent-seeking activities have serious implications for income distribution as well.

Who benefits most from rent-seeking? The weak and the poor, or the rich and the influential? Who do you think?

Rent-seeking theorists hypothesize that in many countries the distribution of income we observe may be more the unintended and untenable product of successful rent-seeking activities than of skewed ownership of factors of production. This is certainly true of Bolivia, Venezuela, Argentina, Kenya and Brazil.

Those groups who, because of political, familial, or other connections, manage to get access to scarce franchises, or to subsidized credit, or manage to have quotas imposed on imports of a product they produce, can end up with huge income that bear little relationship to whether or not they can produce efficiently.

Thus, the rent-seeking literature maintains that access to public government favors may be almost as important in determining income as access to property and skills.

A U.S. analogue: Washington D.C. had the highest per capita income in the U.S. in 2012. Why? Many consulting and lobbying firms in Washington D.C. are headed by former congressmen and former civil servants. What are they selling?

- Expertise in taxation?
- Expertise in International economics?
- Engineering Skills?
- Commodities?

No, what they are primarily selling is access. Access to government officials, access to government processes.

These “Beltway Bandits” have their counterparts in every national capital in every corner of the world.

Are lobbyists and other rent-seekers evil? Are they always corrupt? Not necessarily. Ask any lobbyist for any pressure group and he will tell you, we are just protecting our client’s interest. Lobbyists in D.C., Paris, Seoul, and Buenos Aires say of their activities in politics, “If you don’t have a seat at the table, you are on the menu.”

Returns to Lobbying:

Lobbying deeply infects commerce everywhere.

Consider just the U.S., where we have better information on rent-seekers, largely because of a free press. Lobbying of government officials for special favors is so common that a firm called Strategas created, in 2002, a lobbying index.

Who were among the biggest corporate spenders on lobbying? Tobacco companies, defense contractors, health insurance firms, private universities, and for-profit institutions.

Strategas uses the intensity of lobbying as basis for creating this index.

Intensity of lobbying = lobbying expenditure as a percentage of the firm's assets.

How has the index performed? Measure share price of 50 biggest lobbying firms against Standard and Poor's Index from 2002 to 2011. The Stategas index has beaten the S&P index every year! S&P is a much better gage of stock market performance than the more familiar Dow Jones average (only 30 firms).

The index shows returns to lobbying firms relative to returns to investment in other firms in S&P index of 500 firms.

A striking result that comes from this index: the return on lobbying is especially high.

What do firms get for their money when lobbying? Returns have been as high as $220 for each $1 spent in lobbying.

Clearly rent-seekers do impose costs on society. These costs are the inevitable outcome of special interest politics. Machiavelli realized this long ago. (Read The Prince.)

The point of the rent-seeking literature is not necessarily that it is "immoral" or evil to seek rents by securing governmental favors such as supply restrictions, government imposed minimum prices (milk, grain) and the like. The point is that, except by accident, government favors bestowed upon special interests are not likely to contribute to economic efficiency or to equity for the economy as a whole.

But that rent-seeking pressure groups usually argue for supply and other restrictions in terms of projected equity or efficiency benefits to the society as a whole. They follow the principal of elevating self-interest arguments to the highest moral principles.

Rent-seeking has been present in many African countries over a long period of time in the colonial era and the modern era.

Consider agricultural policy in Africa. There we can easily verify that agricultural policies have been generally sharply adverse to the interests of farmers, especially small, poor farmers (Nigeria, and especially Ghana and Zambia).

One of the main goals of agricultural policy in much of Africa has been to control food prices for the benefit of articulate and vocal urban elites, such as city dwellers, military and bureaucrats, owners of manufacturing firms.

These rent-seeking activities have been at the expense of the relatively helpless, politically isolated, small farmers and in favor of the manufacturing interests and civil servants.

One of the most interesting things about this literature shows political uses of economic inefficiency.[footnote] In the U.S. and elsewhere economic rents can reflect political uses for governments.
Robert Bates, Markets and States in Tropical Africa (1981), CA: University of California Press.

More on rent-seeking and corruption

Rent-seeking and corruption are not synonymous, but they are first cousins.

Now, what is the international gesture for “waiter, please bring me the check?” (Show finger).

Again, what is the universal international gesture for corruption, bribery, etc? (Two fingers/one thumb).

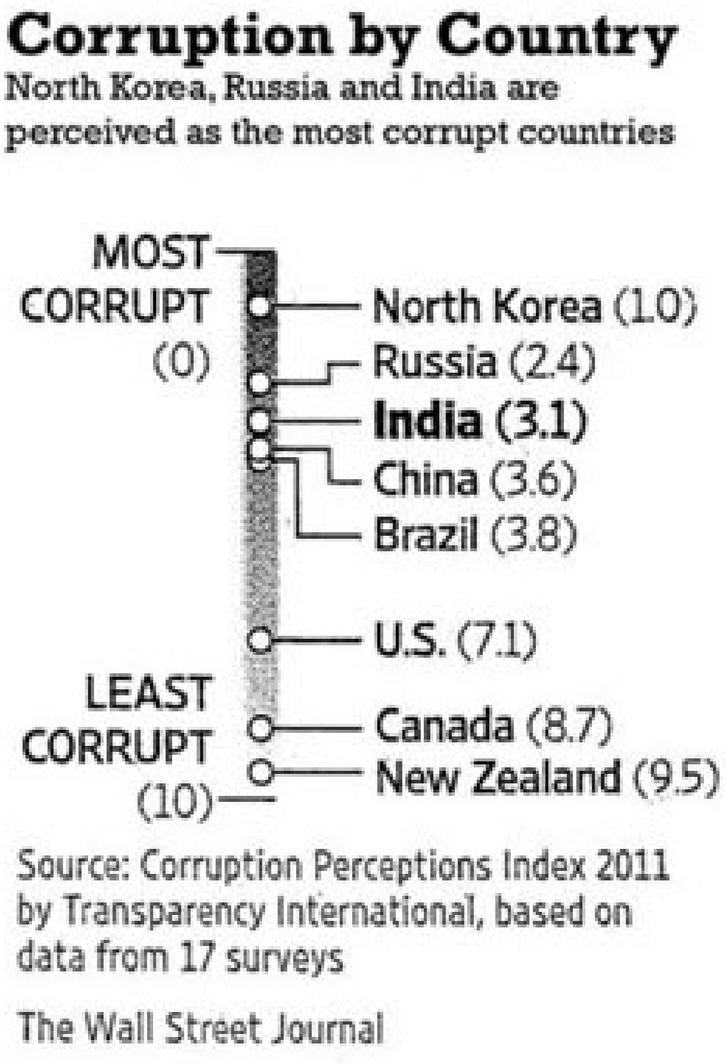
Not all rent-seeking is necessarily corruption (lobbying for congressional earmarks for a hospital in your town is not corruption but may, however, lead to bad government).

But, virtually all corruption tends to fall into the category of rent-seeking.

We do not focus on the moral issues. Only the economic costs of corruption.

Summarize a few studies. Example: A study in Uganda found that 8% of the total cost of running a business was in the form of bribes to government officials. In Argentina, corruption increases the price of hospital supplies by 15%. In Mexico, bribes affected 10% of government transactions. The Indonesian economic meltdown of 1997-98 (economic collapse) was caused partly by decades of corruption corroding almost all institutions across nations.

Consider the Corruption Perception Index. Published by Transparency International. What does the index show?



Corruption by Country

North Korea, Russia and India are perceived as the most corrupt countries

Source: Corruption Perceptions Index 2011 by Transparency International, based on data from 17 surveys

The Wall Street Journal

Now, contrast the "invisible hand" with the "invisible foot." Adam Smith coined the phrase “invisible hand” in 1776 (The Wealth of Nations). He also recognized that in a market system there are going to be pressures for rent-seeking, even corruption.

This quote from The Wealth of Nations describes the invisible foot:

"People of the same trade seldom meet together, even for amusement and diversion, but that the conversation ends in conspiracy against the public, or in some contrivance to raise price."

Hot off the press:

***Southern Economic Journal* 2009, 75(3): 663-680**

Gender, Culture, and Corruption: Insights from an Experimental Analysis

Vivi Alatasa, Lisa Cameron, Ananish Chaudhuri, Nisvan Erkal, & Lata Gangadharan

A substantial body of work has explored the differences in the behavior of men and women in diverse economic transactions. This article investigates gender differences in behavior when confronted with a common bribery problem. Based on data collected in Australia, India, Indonesia and Singapore, while women in Australia are less tolerant of corruption than men in Australia, no significant gender differences are seen in India, Indonesia and Singapore. Hence, findings suggest that the gender differences reported in the previous studies may not be as universal as stated and may be more culture-specific.

Earlier, I mentioned licensing and rent-seeking. Rent-seeking in U.S., well described in (NBER paper #14308 by Morris M. Kleiner, Alan B. Krueger), cited barriers for entry and rent-seeking.

Typical occupations in the U.S. include occupational licensing for barbers, beauty shops, funeral homes directors, architects, etc. Licensing has long been an important unnoticed institution in many labor forces including in Greece, where licensing has hamstrung the economy for decades restricting entry to dozens of actual markets.[footnote]
See Table 1. There Greece ranks 119th in the Index of Economic Freedom, the lowest position for any developed nation.

In the U.S. federal, state and local licensing systems, occupations are subject to license in at least one state. 1,100 occupations were either licensed or certified. In 2006, fully 29% of the U.S. labor force was required to hold some kind of license.

Working a licensed job is associated with wages 15% higher than non-licensed jobs, other things being equal. This 15% differential is largely a rent flowing from restriction or entry into a profession.

Here again, we encounter the inter-connectedness of issues in growth, in this case rent-seeking and income inequality.

For several decades after 1960, economists utilizing the work of Harvard's Simon Kuznets believed there was a necessary connection between economic growth and inequality. Kuznets argued that as growth and development begin in a nation, inequality first tends to rise, largely because of a shift out of agriculture (low wage, but more equal wages) into industry (more unequal wages). But, as the nation develops, Kuznets claimed inequality begins to fall.

The Kuznets hypothesis (Kuznets curve) is not widely accepted today.

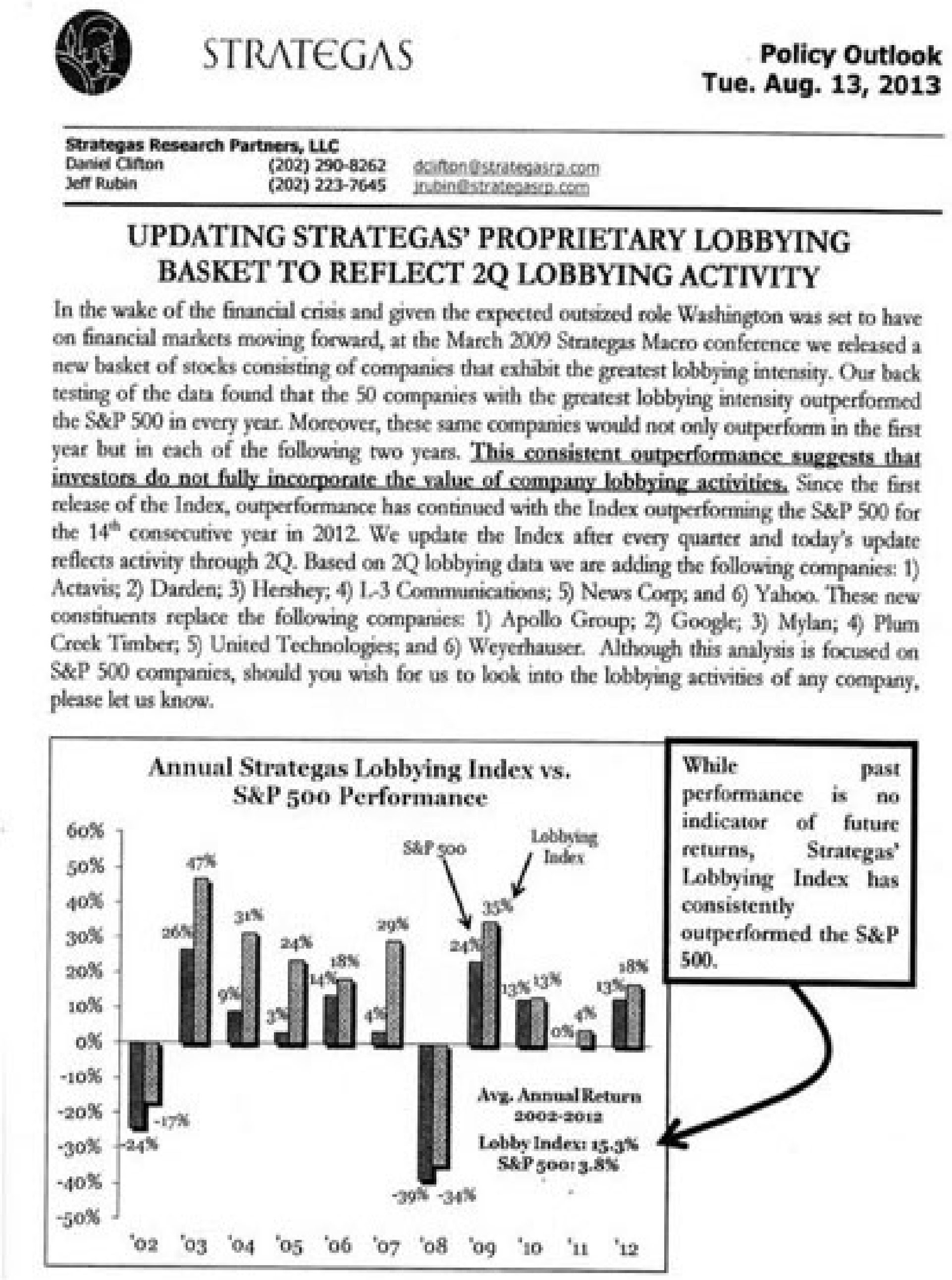
In several recent empirical studies there seem to be no necessary connection between rapid growth and rising inequality. Michael Bruno and colleagues instead found that in a sample of 44 nations from 1981-92, inequality slightly rose with higher rates of economic growth rates in 22 nations, but in the other 22 with higher growth, inequality actually fell. And of course, we know that in the "Gang of Four" nations (Korea, Taiwan, Singapore and Hong Kong) very rapid rates of growth (> 8% year over 3 decades) were associated with rising income equality, not inequality.

At least four factors seem to be positively associated with experience with high growth and improving income equality.

1. Initial condition: where the initial distribution of income and asset before growth takes off, is not skewed (get more equality later)
2. Human Capital: High quality education system (more equality)
3. Labor Intensive Growth Strategies leading to avoiding under pricing of capital, and leading to rapid employment growth. (more equality)
4. Limited scope for rent-seeking activities. Where damages from rent seeking are held in check, whether by constraints on government corruption, the presence of a free press or, above all, openness to foreign trade.

   For those interested in pursuing this topic further, see Jeanet Sinding Bentzen (2012), "How Bad is Corruption: Cross Country Evidence," Review of Development Economics 16(1):167-184.

Figure 13A



STRATEGAS

Policy Outlook
Tue. Aug. 13, 2013

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UPDATING STRATEGAS' PROPRIETARY LOBBYING BASKET TO REFLECT 2Q LOBBYING ACTIVITY

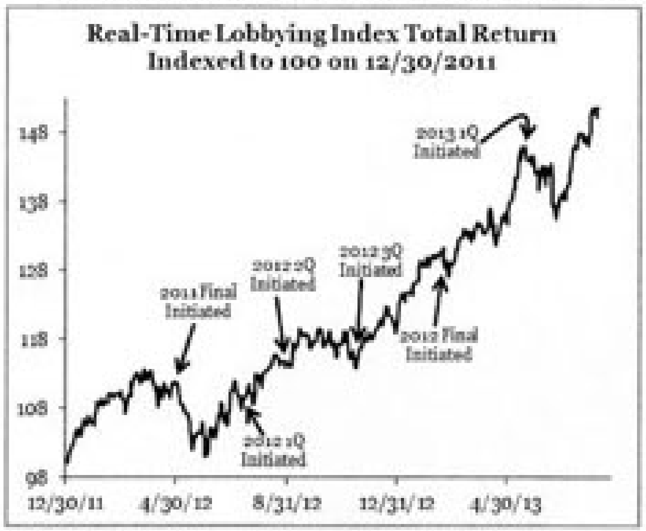
In the wake of the financial crisis and given the expected outsized role Washington was set to have on financial markets moving forward, at the March 2009 Strategas Macro conference we released a new basket of stocks consisting of companies that exhibit the greatest lobbying intensity. Our back testing of the data found that the 50 companies with the greatest lobbying intensity outperformed the S&P 500 in every year. Moreover, these same companies would not only outperform in the first year but in each of the following two years. **This consistent outperformance suggests that investors do not fully incorporate the value of company lobbying activities.** Since the first release of the Index, outperformance has continued with the Index outperforming the S&P 500 for the 14th consecutive year in 2012. We update the Index after every quarter and today's update reflects activity through 2Q. Based on 2Q lobbying data we are adding the following companies: 1) Actavis; 2) Darden; 3) Hershey; 4) L-3 Communications; 5) News Corp; and 6) Yahoo. These new constituents replace the following companies: 1) Apollo Group; 2) Google; 3) Mylan; 4) Plum Creek Timber; 5) United Technologies; and 6) Weyerhauser. Although this analysis is focused on S&P 500 companies, should you wish for us to look into the lobbying activities of any company, please let us know.

Annual Strategas Lobbying Index vs. S&P 500 Performance

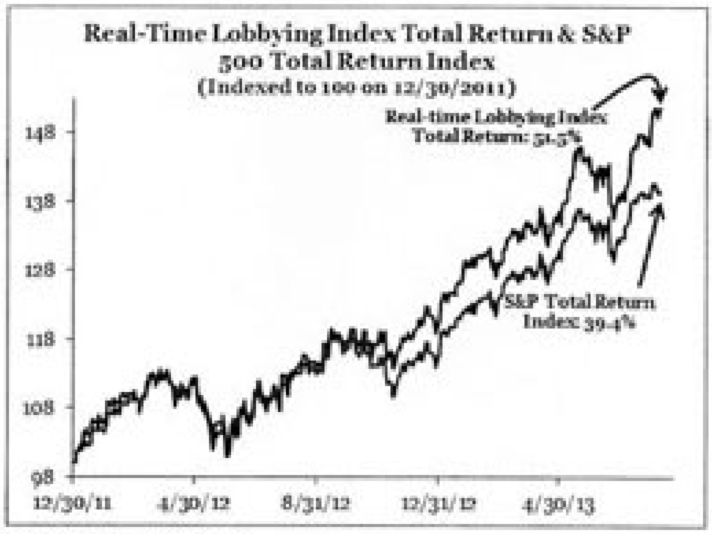
While past performance is no indicator of future returns, Strategas' Lobbying Index has consistently outperformed the S&P 500.

Figure 13B

LOBBYING INDEX IS UP 51 PERCENT OVER THE PAST 20 MONTHS, BEATING THE S&P 500 BY 1200 BASIS POINTS


Real-Time Lobbying Index Total Return
Indexed to 100 on 12/30/2011

We keep track of the Lobbying Index to reflect our quarterly update. Year-to-date the total return of the portfolio is up 25.4 percent, handily beating the S&P 500 Total Return Index by 520 basis points. Since our last quarterly update (May 16th), the Index is up 4.43 percent which outperformed the S&P 500's 2.5 percent gain.


Real-Time Lobbying Index Total Return & S&P 500 Total Return Index
(Indexed to 100 on 12/30/2011)

Return Data As Of August 9, 2013

www.strategasrp.com

INTEGRATION OF ROLE OF K: PRODUCTION FUNCTION APPROACH

At base, economic growth is all about sustained growth in productivity of labor and capital.

Productivity gains arise from:

- Increases in savings and investment in new physical capital
- Increases in savings and investments in new human capital
- Discoveries of new techniques and technologies that enhance productivity and
- Institutional changes that foster growth productivity.

Later in this module we discuss how societies can obtain more savings to finance such investments.

Much of our discussion in the past few modules can be brought together by a simple aggregate production function.

Integration Physical, Human & Intangible Capital

A Production Function Approach to Growth

Production function characterizes how inputs (such as capital and labor) are combined to yield various output levels.

Production functions ordinarily feature diminishing returns to either capital or labor (i.e. a diminishing marginal product of capital or labor).

But some production functions feature constant returns to scale. Some production functions feature fixed coefficients – i.e. that factors such as capital and labor must be utilized in fixed proportions to each other.

A) The COBB-Douglas Two Input Production Function

The most basic production function is written: $Y = L^b K^c$

Where:

b = power associated with input L

c = power associated with input K

L = Quantity of Labor inputs

K = Quantity of Physical Capital inputs

This framework first appeared in an article published in 1928 by James Cobb and Paul Douglas.[footnote]
James Cobb and Paul Douglas. 1928. “A Theory of Production,” The American Economic Review 18:1.

A special, useful form of the basic COBB-Douglas function is ($Y = L^b K^c$) where $(b + c) = 1$: A Linear homogenous production function

When this obtains, we get constant returns to scale (doubling both inputs will give us an output (Y) that is exactly double the initial output). This is called a linear homogenous production function.

In this formulation, the growth rate of an economy is nothing more than the sum of productivity growth of capital plus growth in the labor force.

B) Other Production Function Approaches to Growth

(1) Rudimentary Function: By the mid 1900s, economists and others thought that output (income) in an economy was best understood as an interaction in which existing technology transformed 3 inputs into output: Land, Labor, and Capital). You could write that relationship as:

$Y = f(L, P, K) + Z$
Y = output

f = the production function, or technology, that converts inputs into outputs
P = Land
K = Physical Capital (Human Capital not included)
Z = unexplained residuals, or “white noise” from missing factors not included in the analysis
L = Labor

In this economy, the rate of growth of output would be

dy

d_t t = time

(given by the total derivative)

dF (o)

d_t of the protection function

In this formulation, Output Changes (ΔY) are entirely due to change in the quantity of factor inputs L,W and K; changes in technology play no role at all.

In particular, this model tells us that the more land or workers or capital a nation has, then the greater will be its growth rate and economic power. This theory attempts to explain what would be expected when a nation puts a larger percentage of its population to work, i.e. its economy will become larger. When the number of “people” increases, as for example from an expected increase in the female labor force, then the model would yield a jump in output. The same holds for land. Indeed, such one-time jumps can be a very important source of increased economic might. This is one reason why Germany and Japan sought conquest of other nations in the 1930s and 40s. (Hitler stressed “lebensraum” - more room for life, for Germany.)

This may also provide some insight on why the European powers sought to gain ever-larger colonial empires in the later 19th century.

A principal problem with this classical production function was that it could not explain the sources of productivity growth, or its dynamics, over time. More specifically, this function had no place for innovation. Finally, and most importantly, there was no role for human capital.

(2)A more useful Production Function: In his pioneering work in the theory of "endogenous growth," Paul Romer of Stanford University extended the Model of Robert Solow of MIT to incorporate innovation into the formal theory of economic growth. There is considerable debate as to how far his model makes growth endogenous. Romer's Model brought innovation and R&D to the forefront. Previously, these factors were treated in a most unsatisfactory manner as in the "residual" term of the Solow model. We can write:

$Y = F_t (L, P, K, H, I) + Z$

Here the new terms are (I), denoting innovation and (H), standing for humancapital. **K** now stands for physical capital only. The subscript **t** in **Ft** indicates the technology function **F** that maps inputs into output changes over time **t** due to the dynamics of innovation and technological change. The rate of growth **dY/dt** in such a model will be the total derivative **dFt(o)/dt**. The letter **(Z)** is the residual. This, in turn, will be a complex function showing how changes in the five variables (**L**, **P**, **K**, **H** and **I**) translate into a change in output **Y** over time.

While this was an advance in thinking, it was not sufficient. This model still falls short of what is needed, namely a model that explains how two different economies possessing the same values of the independent variables **L**, **P**, **K**, **H** and **I** can have completely different growth rates **dY/dt**.

That is, there must be additional variables missing from **(2)** (Romer's approach) that cause the five independent variables to be transformed differently into different growth rates of output.

A Much Better Production Function: Traditional growth theory along the lines sketched above has been a branch of "economics proper." Political, legal, and sociological factors were usually not included in the models of economists who work in this field. This situation is changing rapidly. Recent research has shown that the true determinants of economic output and growth include not only the five independent variables appearing in **(2)**, but a host of other quite different variables, including the incentive structure in the economy. These include such institutional features as the quality of the legal system (e.g., the efficiencies of government regulation), the quality of the educational system, the average and marginal rates of taxation, the extent of leverage (debt) that accumulates in the economy, the extent of private and public sector corruption, the degree of compliance with the tax code, the incentives to retire early versus late, the penalties for excess pollution, the incentives to have few or many children, the regulation of immigration, the level of public safely, and the protection of property rights. These factors play no role in models like **(1)** or **(2)** above.

(3) Incentive Structure Effects on Growth: Taken together, these variables define the incentive structure within which economic activity is carried out in an economy. Think of the incentive structure of a society as the collection of all “sticks and carrots” (penalties and rewards) influencing the decisions of all agents as they decide what to produce or not to produce. If top tax rates are 90% (as they were from 1945-69), agents will probably stay in bed or go on long vacations or hire legions of expensive lawyers to help avoid taxes. If tax rates are 20%, they will probably work harder and hire fewer lawyers. As a result of the role of incentive structures, citizens in two essentially identical economies (i.e., economies possessing identical values of the land, workforce, capital, and innovation variables in **(2)** above) will experience very divergent rates in growth in output and living standards. This will be due todifferences in the incentive effects of tax rates, regulatory burdens, and legal provisions such as sanctity of contract, property rights, etc. To incorporate these factors, we need a more general growth mode, as in (3).

$$Y = F_t (L, P, H, K, I, IS) + e$$

$$Y = f_t (L, P, H, K, I, IS) + e$$

where **IS** denotes the incentive structure of the economy that may have evolved by design or by accident. Equation **(3)**, furnishes a more general framework that can, in principle, explain what fuels growth rates in several types of economies. It helps to explain growth in economies that conform perfectly to classical textbook assumptions and that grow in accord with equation **(2)**. It also helps to explain stages of growth in nations such as China between 1950 and 2010. During the period 1950-1963, we noted that there was only modest growth. From 1963-1980, during the Cultural Revolution due to nationwide economic and social disruption, China had negative growth. But after 1982, China experienced an astonishing 10% growth rate thereafter. Classical growth theory cannot explain such phenomena at all, whereas variations in the incentive structure can. This is the advantage of model **(3)** over **(2)**.

Once we know how a particular **IS** variable impacts growth, and why, we may begin to understand which particular values of the **IS** variables are most supportive with strong growth. As we discuss later in this book, once policy- makers understand that taxes on consumption are much more efficient than taxes on labor because of their relative incentive effects, countries might consider adopting a tax code tilted towards consumption on the basis that it is "incentive structure compatible with optimal growth," whereas taxes on payrolls are not. We may note at this point that over 150 nations now have central government taxes based primarily on consumption: the value-added tax.

Selecting a Growth Rate: There is a second property that incentive structure variables have in common: **IS** variables are almost always policy variables chosen by governments, in contrast to classical land and labor variables that are usually exogenous and "taken as given." Importantly, since **IS** variables are chosen, **IS** variables can be changed as a matter of policy, just as they were so spectacularly in China when Deng Xiaoping said in 1978, "It's okay to go get rich!" After further reforms, the growth process there took off in 1982 and remained strong though 2014.

By contrast, countries can be said to be "stuck" with a pathological incentive structure, and, by extension, with low growth. Greece over the period 2008-2014 has been the poster child for this incentive structure. We might conclude that the highly diverse growth rates that have been observed in history have themselves been chosen to a certain extent via their governments' choice of incentive structures.

Analogously, countries can choose growth rates in the future. We now understand what polices are compatible with growth, and which are not.

STATES AND MARKETS - SOEs

State-owned Enterprises

State-owned enterprise almost everywhere is known by the acronym SOE. SOE^{s} turn out to have very significant, and not always positive, effects upon economic growth and development. Moreover, the role of SOE^{s} in exploiting natural capital such as oil and mineral reserves looms quite large in several large emerging nations. As the next few chapters focus on natural capital, this is an appropriate time to examine the advantages or disadvantages of these enterprises.

Therefore, we now consider the role of SOE^{s} in economic development, primarily, but not exclusively in emerging nations.

An SOE is a firm owned or controlled by the government. The government can exercise control with 100% ownership as with Mexico’s PEMEX and Saudi’s Aramco. The government can exercise control with 51% of the shares or, as in the case of Brazil’s Petrobras (oil), 40%.

Much of what we will observe will not be cause for cheer. SOE^{s} the world over are often overstaffed and inefficient. Sometimes they are quite corrupt, such as the Venezuelan oil SOE Petróleas de Venezuela, S.A. (PEVSA) or Mexico’s PEMEX.

PEMEX was created in 1938 when the Mexican government nationalized all oil companies operations in Mexico. For the next 50 years PEMEX functioned reasonably well, exploiting older oil reserves discoveries in the 30s and 40s. But by 1990, the enterprise began to encounter difficulties. Production declined over the next quarter century, not because of a lack of petroleum endowments, but because of the inability of PEMEX to discover and develop new deposits. As production of oil declined, losses rose. Losses from operations grew steadily from 2005-2013.

As a result, the Mexican government announced in 2014 a major restructuring of the company.

These outcomes are not inevitable. We should not think that private sector firms are inherently superior to SOE^{s}. There are capable people in both. The problem is not generally a people problem.

The central problem with SOE^{s} are two fold. First is that nearly all of them never face a market test. A money-losing, inefficient, private firm will eventually go belly-up, like Lehman Brothers in 2008. Some, however, are rescued by government like Bear Sterns or General Motors. If the government rescue is successful they may remain in operation and return to profitability.

It is not necessarily true that managers in SOE^{s} are generally incompetent and those in private firms are generally competent. The second principal reason for inefficiency and losses in SOE^{s} is the incentive structure faced by managers.

A private firm faces an incentive structure that says “control costs and grow revenues, or go broke.”

An SOE faces a much more complex and often inconsistent incentive structure:

1. It must often produce goods prescribed by the government, at prices prescribed by government.
2. It must often employ extra workers far beyond the production needs of the firm, often for political reasons.
3. It is often required to undertake social obligations such as housing for employees, construction of buildings for politicians and the like.

State Capitalism

State capitalism attempts to combine the powers of central governments with the powers of capitalism. Under state capitalism the government may fully or partially own enterprises, or it may exercise direct or indirect control over key enterprise decisions.

The Chinese and Russian versions of state capitalism in the 21st century are sometimes called authoritarian capitalism.[footnote]

MacGregor

Previous examples of state capitalism include:

- Japan (1880-1940)
- Germany (1870s and 1930-45). State capitalism in Germany in the latter period was better known as National Socialism
- Italy under Mussolini (1925-1945)
- Indonesia under Sukarno (1949-1969)

The international presence of SOE^s expanded rapidly in the late 20th century. In the process, the national identities of SOE^s changed markedly as well.

Before 1990, all the largest firms in the world were private sector firms. Call them PE^s or Private Enterprises. And before 1990 virtually all of the ten largest firms were American-owned.

By 2012, a very different pattern had emerged. By then, three of the world’s ten largest firms were SOE^s, and all three were Chinese.

SOE^s continued to grow in importance in the 21st century. How substantial has the recent shift toward state capitalism been?

In the year 2000, SOE^s accounted for only about 10% of global stock market values (for wholly-owned SOE^s that had been partially privatized, i.e. where government had sold off a fraction of shares to the public). By 2010, this share had doubled to 20% of global stock market values.
[footnote]
The Economist, November 13, 2010

The shift has been especially remarkable when one considers the long term. In 1914, British firms (which then ruled 1/3 the world’s people) accounted for half of international businesses. Few British SOE^s or private firms are now among the top 100.

By 1967, U.S. firms had largely displaced British enterprises in international business. The U.S. share was 50% then. But, this share has been slipping.

Ten years ago, Chinese firms were responsible for less than 1% of international business. By 2010, this share grew six-fold, to 6%, and is still rising fast.

We have seen that economics is not immune to fads and fashions. Conventional wisdom on the efficacy of SOE^s and state capitalism has oscillated from great enthusiasm a half century ago, to strong skepticism two decades ago to once again, growing enthusiasm, until 2012. By 2014 doubts over the efficacy of heavy reliance on SOE^s were again prominent.

Consider the record of experience in recent years.

SOE^s are not confined to emerging nations. There is a 22 member club of rich nations called the Organization for Economic Co-operation and Development (OECD), which includes all developed nations plus Chile. In the OECD countries, SOE^s have a combined market value of $2 trillion, and employ 6 million people. Generally, SOE^s in the developed world are mostly in local electric power generation or water supply, or telecommunications, or as in Norway and Italy in oil and gas.

In the U.S., reliance upon SOE^s has historically been relatively slight. The best known and largest U.S. SOE has been the TVA (Tennessee Valley Authority), which operates hydropower and nuclear power plants in Alabama, Tennessee and parts of other states. Like SOE^s almost everywhere, the TVA pays no income taxes and pays no dividends to the owner, the government. They keep all profits. The U.S. also has had SOE^s in Finance. By the 1990s Fannie Mae and Freddie Mac, two large mortgage insurance entities owned by the government, began to rival the TVA in size. Later these troubled enterprises were supposedly “privatized,” but this was mainly an illusion. Fannie and Freddie after privatization behaved pretty much the same as before privatization. Trouble has been coming for a long time, and finally erupted with explosive force in 2008-11, when both lost tens of billions of dollars.

The overwhelming majority of poorer nations had numerous SOE^s in the 1940s, 50s, and 60s. SOE^s were dominant not only in natural resources such as oil and gas, but in electric power generation and such diverse fields as airlines, aircraft manufacturing, banking, construction and many others. Many of these SOE^{S} were previously owned by the occupying colonial powers. After independence, most of these were nationalized.

Enthusiasm for relying on SOE^{s} to achieve economic and social goals began to wane in the 1980s because in country after country, the SOE^{s} were bleeding losses that hindered, not helped development.

A salient example was Indonesia’s Pertamina, the grossly mismanaged state-owned oil company, which in 1976 had international debts almost as high as Indonesia’s GDP. Only government rescue program saved the firm, at very great cost.

In the 1980s governments in many parts of the world began to either close down or sell off (privatize) their SOE^{s} to the private sector.

In some nations, privatization worked fairly well, as in Colombia. In other nations the process of privatization was deeply flawed, and involved high degrees of corruption. This was especially so in Russia after 1981, particularly in the oil and gas sectors. In still other nations, such as Brazil, the process of privatization brought mixed results, as we shall see.

Still, by 2005 SOE^{s} remained dominant in a large number of economic sectors in emerging nations. More than 75% of Chinese firms were SOE^{s} in 2013. In Russia 62% of firms are SOE^{s}, and in Brazil 38%.

The world’s largest natural gas firm is Russia’s Gazprom. Petrobras, a Brazilian SOE, initially thrived after partial privatization in 1990. The new CEO of Petrobras in 2012 was a former minister of energy in Brazil, not a good sign of independence from the government.

Proponents of state capitalism maintain it combines the best of regulatory tools available to the state with the best of the features of capitalism. History may or may not prove otherwise.

In any case, young people worldwide entering the labor force in the 21st century will have to learn to live with the implications of the resurrection of state capitalism. Before the 21st century, state-owned SOE^{s} only dominated their own country's economy (i.e. their national markets). Today many seek dominance on the international stage, in international markets such as oil, gas, nickel, copper etc.

The Chinese and Brazilian experiences are especially interesting, given their somewhat different histories.

In China, under Mao Tse Sung the government controlled everything, and ran everything into the ground. But since about 1995, China has made some startling economic policy changes, especially those pertaining to SOE^{s}.

- In 1995 there were 1.2 million SOE^{s}
- By 2001, 732,000 of these firms had been closed or sold off
- So by 2001, there were 468,000 Chinese SOE^{s}

The absolute number of SOE^{s} in China continued to decline, but not their assets and revenues. Assets in 2003 were $1 trillion. But by 2010, assets of SOE^{s} were $3.75 trillion. Revenues in 2003 were $650 billion. By 2010, revenues had reached $2.5 trillion.

By 1995, Chinese SOE^{s} fell into three distinct groups.

1. Giant state-owned enterprises in strategic industries such as natural resources, banking, telecom, transport and industry. These firms still act much like government ministries in many ways
2. Joint ventures between Chinese state-backed firms and private firms, usually foreign firms
3. Municipally owned SOE^{s} backed by local governments

In the view of some analysts, SOE^{s} in China are largely concentrated in what the Chinese call strategic sectors.[footnote] It is understood that politicians have much more power and control over state enterprises then is the case in other countries with large state enterprise sectors. Chinese SOE^{s} are political as well as economic institutions. CEOs and other top managers are appointed by the communist party, and indeed are party members. Top SOE executives understand that they must adhere closely to government policies while pursuing commercial goals.

Huang, The Chinese Regulatory STATE

The SOE sector in China is truly huge. SOE^s dominate, very strongly the financial system, especially banking. SOE^s in China (and Russia) account for 1/3 of GDP.

Brazil’s recent economic history well reflects the ebb and flow of enthusiasm for SOE^s.

By the eighties, Brazil had more than 500 SOE^s. By 1990 Brazil began to sell off many of the smaller SOE^s. And beginning about 15 years ago, Brazil developed its own, newer model of state capitalism.

After shedding over 100 SOE^s, Brazil began investing heavily in natural resource and telecom firms, but only after partially privatizing them. This was the case with Petrobras, the National Oil Company, but not VALE, the international hard minerals mining company.

The experiences of Petrobras and VALE furnish interesting privatization outcomes.

VALE (formerly known as Companhia Vale do Rio Doce) was fully privatized in 1990, meaning that 100% of VALE stock resides in private hands. VALE’s economic performance since then has been admirable by any standard.

But in the case of PETROBRAS, the government did not choose full privatization. Rather, the government of Brazil retains majority control. With this authority the government has not hesitated to remove CEOs when displeased, nor to instruct PETROBRAS what prices it may charge for gasoline, diesel fuel and other products,[footnote] often with disastrous results.

By 2014, there were plentiful reports of widespread corruption in Petrobras. Among other problems, corruption helped to increase sharply costs of refining. (Financial Times, October 21, 2014).

And, the instruments of government control over SOE^s in Brazil are not limited to share ownership. Indirect methods are also used, including indirect investment in the form of credits (loans) to SOE^{s} from Brazilian SOE^{s} in banking.

This pattern of control has also been quite common in other nations with large SOE sectors, especially China. It was also characteristic of the SOE sector in Indonesia and Bolivia in the period 1950-80, where state-owned banks were directed (“commanded”) by the government to lend to other SOE^{s}, regardless of their viability. The risk here is that the government (of China, of Brazil), can easily builds itself a house of cards, setting the stage for a financial “time bomb.”

When a Brazilian or Chinese SOE in banking or finance lends to a SOE in other fields, what happens when the borrowing SOE runs into trouble and cannot repay the loans?

The borrowing bank says to its owner, the state as shareholder, we cannot pay. The state stockholder, the government, instructs the SOE^{s} who lent to the troubled firm, “Let it Ride.”

When this happens, problem also multiplies for the SOE^{s} in banking, who have to carry heavy loads of non-performing loans, endangering the health of the entire financial system. This happened in India between 1970 and 1980. It was happening in China and Brazil in 2014.

Notwithstanding the long-standing problems of SOE^{s}, many of the lessons learned about the performance of state capitalism in the earlier period (1945-85) have been forgotten. Even the Economist of London can go overboard on the issue of state capitalism. A quote from an issue in 2008: "State capitalism looks like the coming trend."

Perhaps one reason for such statements has been the emergence of the so called Chinese model of STATE capitalism.

One very salient point - SOE^{s} now heavily dominate the world’s holdings of reserves of oil and gas. These are called NOIs (National Oil Companies). This group includes NIOC (Iran), Aramco (Saudi Arabia), Gazprom (Russia), CNPC (China), Pertamina (Indonesia), Pemex (Mexico), and Petronas (Malaysia). By 2012 NOIs held almost 90% of oil reserves.

However, if in the coming year the U.S. fully taps its now huge reserves of oil shale in Texas, North Dakota, Pennsylvania and Ohio, the dominance of the NOIs will diminish, at least for a time.

In critiquing the performances of SOE^{s}, it is important to recognize that many, management is quite competent, and equal to the best anywhere, except when they are subjected to political pressure from the government-as-owner.

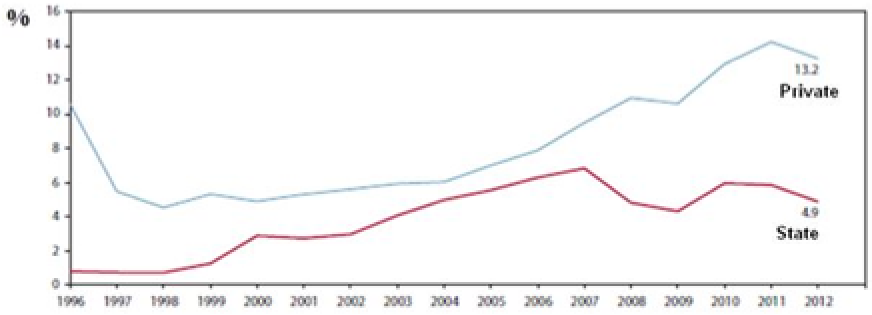
Indeed, there are several examples of reasonably well managed SOE^{s} in oil and gas sectors across the world.

Statoil	Norway (oil)
Aramco	Saudi - especially proficient in IT and in promoting health and safety in operations.
Petronas	Malaysia (oil)
Ecopetrol	Columbia (oil)

Until recently, PETROBRAS of Brazil would have to be included in this list.

In any case the movement for privatization of SOEs in energy nations had largely passed by the year 2000.

China: Annual Report on Assets
State-owned Enterprises and Private Enterprises (1996-2012)



Source: Peterson Institute for International Economics

Why many SOE^s are unprofitable

Profitability in SOE^s tends to be low because the government-as-owner often utilizes them to typically pursue other aims of the state, including:

- Employment, sometimes leading to excessive payrolls
- Political rewards to government officials
- Military needs (there military-owned SOE^s in Iran, Pakistan, etc.)

And often SOE^s pursue social aims unrelated to their businesses.

In China large private firms in 2012 had an average return on equity of 13%. The reported return in SOE^s was 8.2%, and even that may have been inflated.

What can be said about recent profitability in SOE^s? What can be said about efficiency in SOE^s, in big countries such as Brazil, China and India?

Over the period 1996-2012, the average return on assets for Chinese SOE^s was less than 5% from 1996-2010, and barely above 5% thereafter. By 2010, returns to private firms were 3 times higher (see Table 11-1).

For China, the average return on equity in 2010 for companies wholly or partly owned by the state was only 4% (in spite of the fact that these firms receive cheap credit from Chinese SOE^s in banking).

The profit performance of Chinese SOE^{s} has been abysmal.[footnote] Properly interpreted, the real return on equity invested in Chinese SOE^{s} was a negative 6.3% from 2001-09 (considering reported SOE^{s} profits minus subsidies to SOE^{s}).
James McGregor, p

Another estimate for 2011 revealed that while the average SOE reported return on equity was 8.2%, the real return was a minus 1.5% (factoring in the subsidized borrowing of SOE^{s} from state SOE^{s} in banking and their access to land at below market prices).[footnote]
The Economist, June 25, 2011.

What is the meaning of a negative real return on equity? It means that, in effect, many SOE^{s} in China are destroying capital.

India has 217 SOE^{s} owned by central government. And then there are the 850 SOE^{s} owned by regional governments. Of central government enterprises, 59 made losses (21% of firms. Some very large SOE^{s} made huge loss in India). The combined losses of two very large SOE^{s} – Air India and MTNL (Telecom) - was $2 billion in 2010. Even so, the government of India claims that the rate of return on equity invested in their SOE^{s} is 14-15%.

Employment Issues, Efficiency Issues

Employment

In most nations, SOE^{s} are not only expected to provide jobs for politically connected workers, they are also expected to retain workers on even when revenues go down permanently. In effect, SOE employees cannot be fired. Thus over time the result is heavily padded payrolls: many more workers, sometimes thousands more, than would be needed to produce the firm’s product or service.

This conclusion has been borne out in numerous studies over the last thirty years, including some of my own. Recent studies reveal similar patterns. To illustrate, a very large World Bank study in 2009, 926 SOE^{s} and 301 private sector firms around the world in electricity distribution and water supply

and sanitation (1,200 firms) clearly showed significant overstaffing in the SOE^s relative to the private firms.[footnote] Regarding employment in water and electric enterprises, the study revealed clearly that SOE^s used 23% more employees that comparable private firms.
IBRD - Cite

This marked tendency for many SOE^s to use more labor than needed is particularly problematic given this fact: Investment patterns in SOE^s all over the world tend to be more capital intensive relative to private firms in the same industry. Why? One reason is that SOE^S in Banking often provide the other SOE^S with cheap credit, making capital cheap, thereby biasing choice of technique or production toward capital intensive methods of production.

This pattern of marked capital intensity in SOE^s has been observed in South Korea, Ghana, Canada, India, Bolivia, Indonesia, Columbia and Brazil, among others. In China, one consequence of the bias toward capital intensity has been a sharp decline in labor's share in national income (N.I.) [footnote] over the years 1992-2009. Labor's share in N.I. fell from 45% to 37% - the lowest share for labor in any county (c.f. U.S. and Germany at 60%).
"The Global Decline of the Labor Share," Loukas Karabarbounis & Brent Neiman, NBER Working Paper No. 19136, June 2013.

Thus, many SOE^s in emerging nations have the worst of both worlds: an excessive labor force (padded payrolls) and marked capital-intensity of their investments. These factors often combine to yield high operating losses.

Both of these factors mean higher costs of production in SOE^s, relative to private firms without excess labor and less wastage of capital.

This gives rise to of X-inefficiency, characteristics of many SOE^s around the world. X-Inefficiency means failure to minimize cost. It is not the same thing as allocative inefficiency. [footnote]
"Allocative and X-efficiency in state-owned mining enterprises: Comparisons between Bolivia and Indonesia," Malcolm Gillis, *Journal of Comparative Economics*, 1982, Vol. 6(1): 1-23.

Consider reasons why might SOE^{s} tend to have a capital-intensive bias in their selection of techniques of production:

1. Many governments provide Capital to SOE^{s} at near zero rates. It is almost always the case that equity capital provided by the government-as-owner carries an implicit price of zero. Examples include COMIBOL in Bolivia, GARUDA in Indonesia, and dozens of others. But in addition, the government-as-owner very often provides its government-owned firms (SOE^{s} in banking) with subsidized loan finance. This is clearly so for China, Brazil, Indonesia, and others. Therefore the cost of capital to SOE^{s} is often zero or near zero, and certainly much cheaper than the market rate of interest. With low capital costs, the SOE will tend to select capital rather than labor intensive techniques of production.
2. Managers in SOE^{s} may prefer capital-intensity, because machines do not go on strike[footnote] and are otherwise easier to supervise than workers. If the SOE manager does not ultimately face a market test he may therefore indulge in capital-intensive choice of technique of production. If a private firm were to indulge in capital-intensive bias, it would run a greater risk of bankruptcy (unless it has a monopoly or oligopoly position in the market). But the government-as-owner can keep the SOE^{s} afloat indefinitely, even if the government itself has to continuously run budget deficits of its own to support SOE^{s}. And indeed, SOE^{s} (other than SOE^{s} in oil or minerals mining, or monopoly SOEs) do tend to run losses over several years. And even some SOE^{s} in oil and mining have incurred large losses over considerably periods of time (Pertamina in Indonesia 1970’s, Comibol in Bolivia in 70s – 80s). In any case, the SOE^{s} sectors as a whole in emerging nations have generally lost money. That is, when one totals up the profits and losses of all the SOE^{s} in a country the result is typically a negative number (less likely if there are big state-owned oil and gas firms). Labor unions are fairly weak in many emerging nations, and fairly strong in others. The latter group would include South Africa, India and most all Latin America nations.

A consistent pattern of losses is somewhat surprising in many where the government owner has given SOE^{s} monopoly privileges.

Ordinarily, this should give rise to SOE monopoly rents, higher than the normal return to K. But even with monopoly privileges, the net return to capital can be negative because of X-inefficiency in the SOE^{s}.

There is yet another reason for poor financial performance of SOEs: the need to deal with social responsibilities imposed upon them by the government as owners.

These “social responsibilities” are significant for two reasons:

1. They typically inflate SOE costs, and are partly responsible for failure of many SOE^{s} to minimize costs
2. The social responsibilities assigned or presumed for SOE^{s} are very often used as an excuse for SOE operating losses.

Some of the social responsibilities assigned to or otherwise accepted by SOE^{s} around the world are:

1. Rectifying social imbalances, such as those resulting from past ethnic or other discrimination. Examples include India, Malaysia, and Bolivia
2. Provision of expensive housing and other amenities for managers of SOE^{s} (including golf courses as in Indonesia’s P.T Timah (tin) and limousines in Ghana)
3. Rectifying regional imbalances (using SOE budgets to help lagging regions catch up through requiring the firm to invest heavily in road construction or infrastructure)
4. Performing giant building projects for the government as owner. Example: Pertamina built The National Legislature Assembly largely from building materials flown in on C-140s from the U.S. This is no way to minimize costs. Another example: Aramco built the entire campus for King Saud University of Science and Technology at the cost of tens of billions of dollars.

All of these factors distract SOE^{s} from their principal activities and clearly drive up costs.

The “social obligations” of SOE^{s} are very often used to justify their losses. That is the tired old apologies for inefficiency and losses in SOE^{s} long offered in Bolivia, Indonesia, Italy and the U.S.

Example: Fannie Mae and Freddie Mac, the mortgage giants created decades ago as SOE^S to ensure home mortgages. In the 1980s, both SOE^S were partially privatized. Both cost taxpayers hundreds of billions of dollars in the economic meltdown of 2008. But even in 1999, the two firms were in terrible shape. Larry Summers was President Bill Clinton's Secretary of Treasury in 1999. Here is what he had to say about them. To quote, " "The illusion that the Fannie Mae and Freddie Mac were doing virtuous work made it impossible to build a political case for regulations. When there were social failures the companies always blamed their need to perform for the shareholders. When there were business failures it was always (said to be) the result of their social obligations. Government budget discipline was not appropriate because it was always emphasized that they were 'private companies.' But market discipline was nearly nonexistent given the general perception -- now validated -- that their debt was government backed. Little wonder with gains privatized / and losses socialized / that the enterprises gambled their way into financial catastrophe." " Both were major causes of the 2008 economic meltdown.

SOE^S and the Environment

Would one expect government-owned firms everywhere to pay more attention to the environment? Would one expect SOE^s to be more responsive than private firms in reducing air and water pollution that might be associated with what the firms produce?

To be more precise, would one expect a government owned electric power producer to emit less CO_2 or to pollute rivers less than a private firm?

A common reaction would be yes, of course. Firms owned by government should "naturally" be expected to be more careful about environmental damages. But experiences all over the world suggest otherwise. Rather, state-owned enterprises generally tend to be less responsive and less sensitive to the need for a cleaner, sustainable environment.

An early example was the TVA in the U.S. From about 1945 until at least 1990, the biggest polluting firm in the U.S. was TVA.

SOE^{s} in the former Eastern Bloc nations were responsible for some of the worst river and air pollution ever seen. The Vistula River in Poland is one example. In the 1980s Czechoslovakia countryside, the water table was so polluted by SOE^{s} that no one could drink the water.

Consider, China, where SOE^{s} have long predominated. In January 2013 the air in Beijing hit a level of toxicity 40 times the level the World Health Organization (WHO) deems safe. Of the twenty most polluted cities in the world, sixteen are in China. Almost every river flowing through urban areas is highly polluted, unfit for almost any purpose. Between 8% and 20% of Chinese arable land now shows heavy metal contamination. In China this has led to rapidly worsening environmental problems, so large as to “pose a growing threat to economic development.” This was a quote, on February 20, 2012 from Mr. Hu Siyi, Vice-Minister of Water Resources in China.

The bias toward capital intensive growth has also been one factor responsible for unintended environmental damages. These damages have been considerable in several larger emerging nations. These damages include those to human health from air and water pollution to excessive depletion of natural resource endowments. Table 11-1 presents estimates of such damages for three emerging nations and three developed ones.

China leads the list, with damages at 9% of Gross National Income. India follows close behind, at 8.5%. Brazil is in the middle at 5%.

China	9.0%
India	8.5%
Brazil	5.0%
U.S.	2.3%

S. Korea	1.0%
Japan	1.0%

Environmental Damages as% Gross National IncomeSource: World Bank, as cited in The Economist, April 13, 2012.

Dozens of other examples could be cited from Indonesia to Bolivia, Vietnam, Ecuador, Zambia, or Romania.

Oil spills have not been confined to firms such as British Petroleum. They have been quite common in oil SOE^s in Ecuador, Mexico, Bolivia and Venezuela. Rarely are these costs subject to cleanup.

Not all SOE^s tend to be less sensitive to the need to avoid environmental damage from operators. For one example, in recent years the huge Saudi SOE in oil, ARAMCO, has sought to prevent spills into the environment and to emphasize cleaner environment operation generally.

The interesting question, however, is not whether but why SOE^s have been able to ignore environmental costs they have caused.

Reason #1 Sovereign Immunity
In many, perhaps most nations, the state has sovereign immunity. One cannot sue the state to make it stop polluting. One cannot take the state to court. This is why TVA in the U.S. was for so long the biggest polluter in U.S. Private firms polluted too. But one can sue them, take them to court. Sovereign immunity also applies in most other nations in the author’s experience.

Reason #2 Central Planning
This helps explain why SOE^s in Poland, Czechoslovakia, Bulgaria, East Germany and Russia in the thirties, forties, fifties, sixties and seventies were among the worst polluters. With Russian style central planning, as prevailed in those countries till about 1990, the objective of firms was not profit maximization and certainly not cost minimization.

The objective was output maximization. The firm must produce its state prescribed quota of sardines, shoes, bombs, or else. And if that meant highly polluted air and water, so be it.

Now consider the relevance of the “China model” with heavy reliance on SOE^{s}. Even many influential Chinese now think the “model” is outdated. In a report by IBED and the government of China released in 2013 says “China must scale back its vast SOE sector, and make them operate more like commercial firms.”[footnote]
Wall Street Journal, February 23, 2013, p.1

NATURAL CAPITAL & SUSTAINABLE DEVELOPMENT
INTRODUCTION

Introduction to Natural Capital

We have earlier considered the role of physical capital, human capital and intangible capital. Now we turn to natural capital and sustainability issues beginning with some general introductory comments. Then we will turn to four specific areas in natural capital utilization and conservation.

1. Tropical forests
2. Energy- including nuclear energy
3. Water
4. Fisheries

We will also consider the implications of natural exploitation for climate change (especially energy) and what climate change means for water, fisheries and forests.

Sustainability

The concept of sustainable development was unfamiliar to economists 25 years ago when it was “rediscovered”. There is even now a Dow Jones sustainability index. (Dow Jones once owned *The Wall Street Journal*). The Dow Jones sustainability index is both a guide for managers who lead “green” businesses and to governments who seek “green growth.” It is also a “report card” on the “greenness” of U.S. business firms. Some firms talk the talk, few walk the walk on sustainability. This is also true of governments.

Sustainable development is not a new concept. For at least 500 years the concept was integral to daily life in Native American tribes in both the U.S. and Canada. The Choctaw, Cherokee, Sioux and Navajo, to name a few, had definite ideas about sustainability. Indeed in most tribes the interaction between humans and the natural environment was an important basis of their values and their religions. Consider this quote from the famous chief

Thasunke Witko, known by settlers (and General Custer) as Crazy Horse, who was a thoughtful and visionary leader in the Sioux tribe:

"“Treat the earth well. It was not given to you by your parents. It was loaned to you by your children.”"

In 18th century America even the European interlopers had notions about sustainable development. Thomas Jefferson, in 1789, wrote:

"“The earth belongs to each generation. No generation can contract debts greater than may be repaid during the course of its own existence.”"

Under other labels, sustainable development has engaged the interests of physical scientists and economists since the early 19th Century, when Reverend T.R. Malthus predicted an inevitable and ongoing collision between population growth subsistence and sustainability.

But, Malthus did not foresee the waves of technological revolutions in industry and science that were yet to come. Also, he did not foresee the behavioral changes that helped fuel fertility decline in the past thirty years. Both these factors have kept the Malthusien “wolf" at bay in most of the world. But can the world avoid a Malthusien apocalypse in the future?

To answer that question, we will need to turn our attention to the creation of conditions favorable for sustainable use of nature’s bounty.

Sustainable development is basically about trying to have “green growth:” economic growth for the current generation that does not jeopardize future prospects for growth or well-being of future generations. And the well-being of both the current and future generations depends on clean air to breath, clean water to drink and much more.

My own preferred definition of sustainable development[footnote] is as follows:

See Malcolm Gillis, Dwight Perkins, Michael Roemer and Donald Snodgrass, Economics of Development, Third Edition, 1996, p.524.

Economic development that maximizes the long-term net benefits to human kind, taking into account the very real costs of environmental degradation and natural resource depletion.

These benefits include:

a. Income gains
b. Reduction in poverty and unemployment
c. Healthier living conditions, longer lives

Costs include:

a. Those associated with pollution of all kinds (water, air, soils etc.)
b. Those associated with resource depletion

Sustainable development stresses the need to develop sensibly, in order to be better able to conserve. It makes conservation the handmaiden of economic growth, while protecting the interests of unborn, future generations.

Seen this way, conservation and preservation are not valued for their own sake, but what they can do for welfare of both present and future generations.

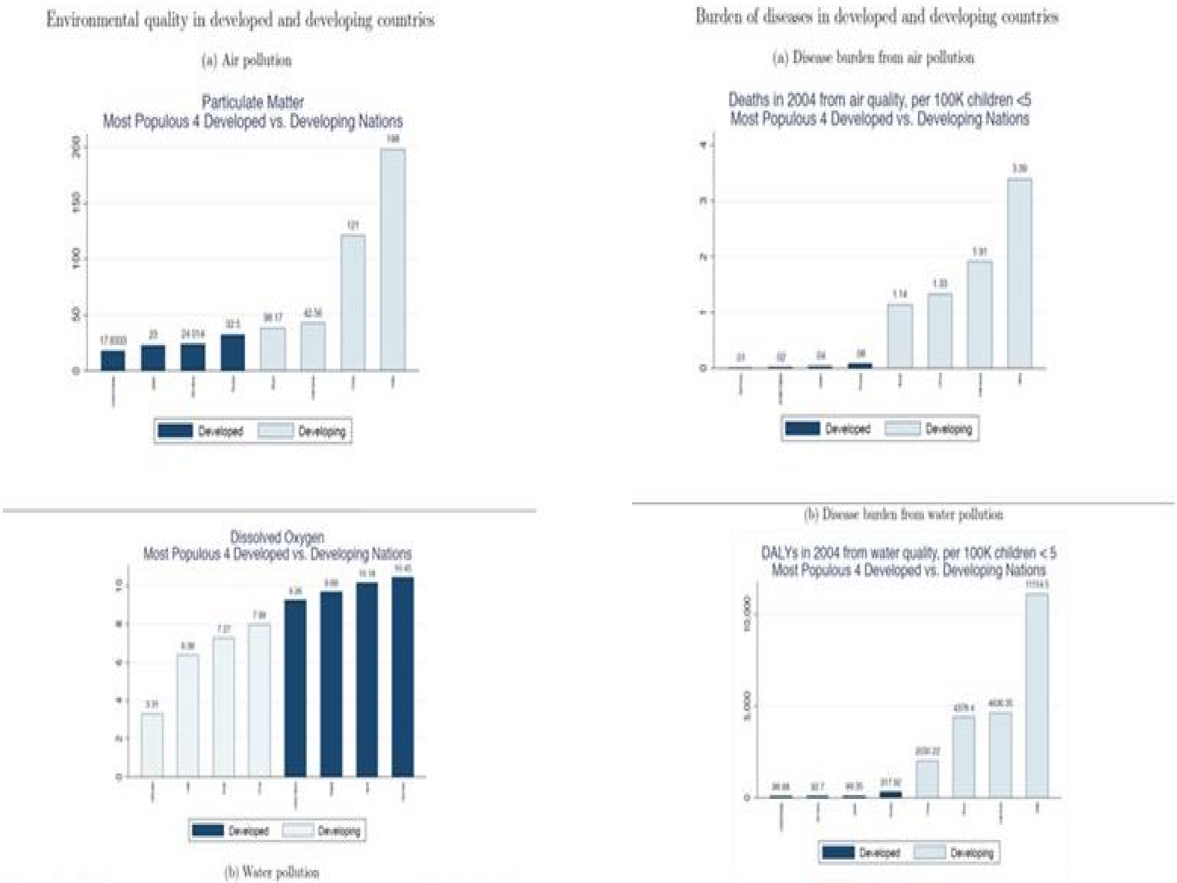
We have in fact progressed. Decades ago few cared when federal officials called the incredibly polluted Houston Ship channel “too thick to drink, and too thin to plow.”

By 2008 fully 85% of the American public believed that global climate change was a serious issue. Sometimes moral arguments are offered for sustainability. For example, Christians speak of “sins of omission.” Perhaps pollution is best seen as a sin of emission.

In any case, growing concern over the environment has been accompanied by a heightened search for moral foundations for environmental ethics. This search is not going all that well at present. Should this concern us? Yes. But not to the point that we are distracted from three other very important tasks.

The first of these tasks is to improve not only environmental policies and environmental management, and to improve non-environmental policies impacting the environment. As it happens, many of the most pressing environmental issues in affluent counties are caused by affluence. They are much more often management issues, rather than moral issues. That is, while moral considerations may cause most of us to agree that the humpback whale, the whooping crane, the grizzly bear, and the bald eagle should all be saved, we have a very limited number of proven programs to assure survival of these endangered and/or threatened species.

Environmental Issues in 2011 Developed vs. Developing Nations (Large Countries Only)



Notes: Panel A shows average particular matter from urban centers, in $\mu g/m^3$, using data from the World Health Organization (2011). Panel B shows dissolved oxygen, in mls/litre, using data from the United Nations Environment Program (2001). The four most populous developed and developing countries are shown, ranked according to the pollution measure.

Notes: Panel A shows the burden of disease in deaths among children under 5 per 100,000 from outdoor air pollution. Panel B shows the burden of disease in deaths among children under 5 per 100,000 from water, sanitation and hygiene. Data are from the World Health Organization (2004) for the 4 most populous developed and developing countries.

Source for all graphs: Michael Greenstone and Kelsey Jack, "Envirodevonomics: A Research Agenda for a Young Field", NBER Working Paper #19426 (2013).

What is the second task? To cause people to understand that in most of the rest of the world, outside of the U.S., Europe, or Japan, the most serious environmental issues are caused not by affluence, but by poverty. If one wants to save the snow leopard in Nepal, the tropical forest in Indonesia, the panda in China, and the rhino in Africa one has to understand that efforts to protect endangered species in poor nations will be fruitless unless and until something is done to give poor rural families a stake in preserving these animals and their habitats. Differences in environmental issues as between rich and poor nations are well illustrated in Figure 15-1.

The third task is to craft sensible measures and policies for mitigating or resolving serious environmental threats. These tasks are daunting, but they are tractable if approached with the requisite degree of humble optimism.

This brings us to a discussion of doomsayers, soothsayers, and doomslayers.

Doomsayers have always been with us. Think of Cassandra in the *Iliad*. Consider the widely expected environmental catastrophes wrongly forecast by the Club of Rome in the 1970s. They predicted the world would be running out of everything by the year 2000. Consider the population doomsayers: they foresaw as late as 1990 a terrible population explosion. We have seen that fertility decline coupled with technological innovation has been the undoing of these predictions. I do not listen much to doomsayers, nor to soothsayers, who assure us we have no problems, whether in climate change or looming water scarcity. The company of doomsayers is to be much preferred those who work on measures to avert doom. However, even the best doomslayers cannot provide panaceas. Finally, it behooves us to remain skeptical of panaceas of any kind, including those related to the environment. Panacea was ancient Greek for “I can cure it all.” Interestingly in Modern Greek panacea means “wig” (cover all).

Since panaceas are not available for resolving environmental problems, resort must be made to a portfolio of measures, which together can make enduring differences in resolving environmental issues.

I first began working in sustainable development in 1971, researching tropical deforestation in the jungles of Indonesian Borneo. This led me to searches for causes and cures for tropical deforestation in Indonesia, in Africa and Latin America. Over time, these interests extended also to issues such as acid rain, air and river pollution and then energy conservation. These experiences led me to hold views on measures for sustainability that were considerably more market-focused than prevailing received wisdom. Received wisdom, then and now, focused almost exclusively on the role of market failure in environmental degradation and the need for extensive government regulation. There was an old song in the 1940s titled: "The Best Things in Life are Free"[footnote]. Market failure says: some of the worst things in life are free (pollution). In this collection, our focus is primarily upon market failures leading to environmental depletion and degradation.

The Inkspots, 1947.

In well-functioning markets where competition prevails, market prices are reasonably reliable indicators of scarcity values. However, there are conditions that cause markets to fail. In such cases private producers and consumers face prices that deviate from scarcity values, causing them to make decisions that may maximize their earnings, but also cause uncompensated losses for others, and for society as a whole. This is market failure.[footnote]

See Malcolm Gillis, Dwight Perkins, et al., Economics of Development, 5th Edition, 1996, pp.156-159.

Common causes of market failure are externalities: costs that are borne by the population at large but not by individual producers, or benefits that accrue to society but cannot be captured by producers. The most important externalities in utilization of natural capital are those arising when resource prices are underpriced. This causes resources to be depleted at unsustainable rates.

[MG INSERT HERE ALSO PARAGRAPHS ON OPEN-ACCESS AS EXTERNALITY].

Market failure does often lead to environmental degradation, but so does public failure - the role of bad government policies in causing resource waste and environmental damage. The ill effects of public failure are almost always unintended.

Early on in Indonesia it became clear that market failure played a relatively small role in the degradation of Indonesia’s then huge tropical forest estate, all government owned. Public failure was largely at fault: the governments’ own timber royalty and tax policies served to deeply underprice Indonesian tropical wood, leading to grossly excessive harvests. Had Indonesia tripled its taxes and royalties on tropical wood in 1975, deforestation thereafter might have been manageable. These taxes and royalties were in fact increased by 75% in the late 1970s, but that was too little, too late, owning to the role of poverty in deforestation, of which more later.

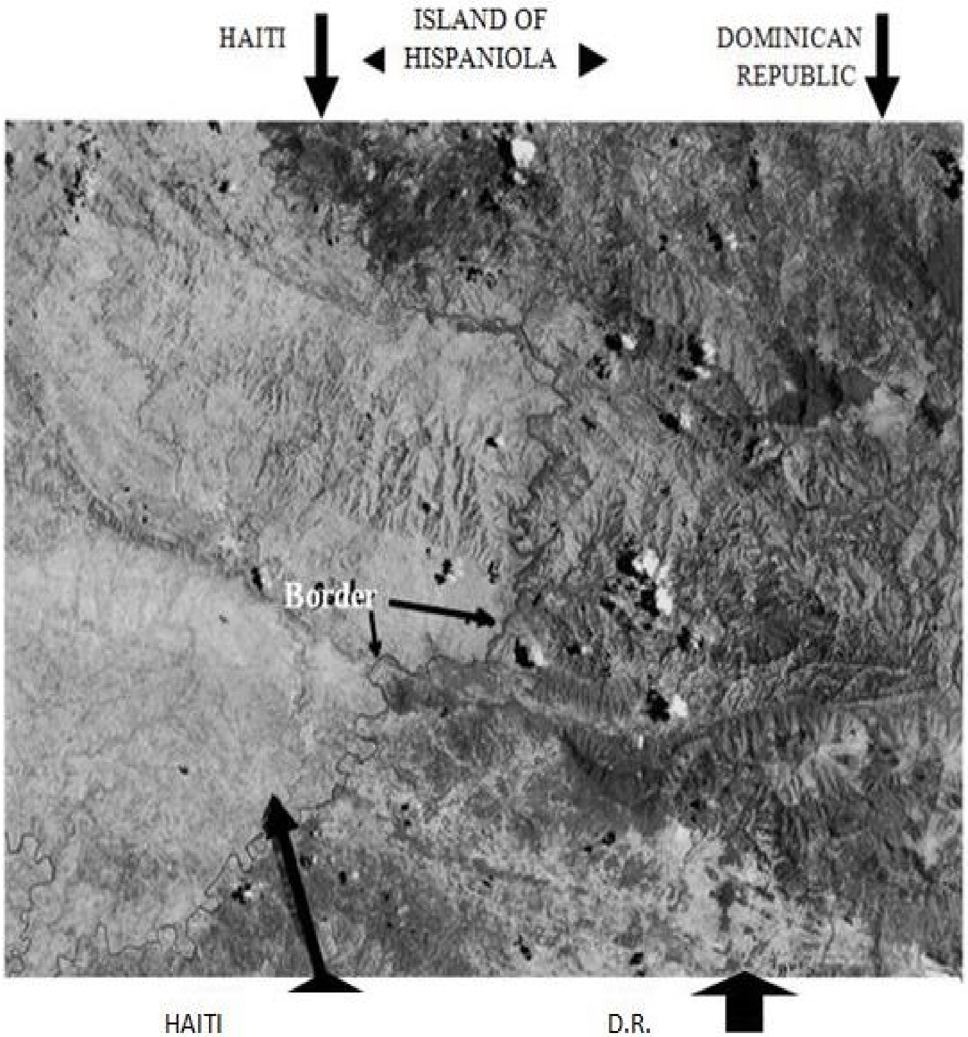
When considering water scarcity problems in Asia and Africa, Latin America, the states of Florida and California, it soon becomes apparent that, after droughts, the prime reason for water scarcity is not market failure, but public failure. There has been a pervasive tendency of government to underprice water resources so that they are shamefully wasted, especially in agriculture (see the example on Aral Sea in the Soviet Union). This vulture is now coming to roost, and not just in Lima and Mexico City, but in Atlanta, Las Vegas, and Los Angeles.

Economists are increasingly coming to realize that for affluent countries such as the U.S., the most serious environmental problems are caused at least by five factors:

1. Affluence, leading to wasteful consumption, especially of underpriced resources such as water
2. Market failure
3. Encroachment on fragile watersheds and beaches as for example by building vacation homes and housing developments on steep slopes in Aspen or Jackson Hole
4. Our addiction to disposable plastic bottles for water
5. And over harvest of our fisheries

In sharp contrast, however, most, not all, of very serious environmental problems in poor countries have their main origins in poverty and government failure. We will see that there can be little doubt that poverty by itself or in combination with public policy failure has been the main cause of tropical deforestation.

Consider the Haiti/tragedy/catastrophe (Figure 12-2)



The island of Hispaniola contains two nations: Haiti and Dominican Republic. Sixty years ago, both were about equally forested. No more. Satellite photos in 1997 reveal a deeply disturbing catastrophe. You could actually see the border between Haiti and Dominican Republic. Decades of extreme poverty has driven extreme deforestation in Haiti, leading to local climate change, drought, severe erosion and disappearance of arable land. And what has driven poverty in Haiti? Very bad policy by two generations of the Duvalier family and their henchmen.

Poor landless Ghanaians, Haitians, Ivoirians and Indonesians infringe on the tropical rain forest, and practice primitive slash and burn agriculture, not because they are ignorant, but because they have no other options.

Slash-and-burn agriculture is only one manifestation of the effects of poverty on deforestation. In many poor nations, the role of poverty in deforestation has been magnified by the ever-more-desperate search for fuel wood by impoverished people. In Ghana in the 1980s, for example, for every tree harvested for lumber, nine trees were cut down for firewood. Deforestation accelerated soil erosion, groundwater depletion, and loss of agricultural productivity. For developing nations generally, 80% of trees cut down in the 1990s were for fuel or other domestic use, not for export as logs or wood products.

We will see in subsequent chapters that government failure has often been a key factor in causing poverty itself – misguided tax policy, inappropriate monetary policy, restrictive trade policy, egregiously bad exchange rate policy, and misdirected agricultural policy. In my experience, I would say that much more often than not, poverty in poor countries has been driven as much by bad policy as anything else. This was surely true for Ghana 1970-85, Haiti 1940-2008, Zimbabwe 1995-2013, North Korea 1946-2013, Nigeria since 1975, Argentina 1945-2000, and Argentina 2011-2014.

Consider Ghana in the 20th century. There, poverty by itself, or in combination with other factors such as rent-seeking, has been the main cause of tropical deforestation.

In 1900, one-third of Ghana’s land area was covered by natural tropical forest. In 1967-71, the forest still covered about 20% of the land; there was still a lot of forest to study. No more. By 1995, forest cover had shrunk to less than 5%.

Elsewhere in West Africa, Southeast Asia, Brazil, and Central America, poverty has also been killing the forest. Poor, landless Ghanaians, Ivoirian etc. have not been the cause of deforestation, but the instruments of forest destruction. There are not the traditional shifting cultivators of Africa or Asia who for centuries past have moved from parcel to parcel. Rather, I refer to the landless, mostly urban people who have become “shifted cultivators,” driven to degrade the forest by hunger and population pressures.

Most of the plant and animal species on earth occur in the tropical forest. The tropical forest once covered 12% of the earth's land surface before extensive deforestation began after 1945. Now it covers less than 6%. Worldwide, the tropical forest estate shrank by about 142,000 square km per year in the 1990s. Of that amount, almost 60% fell to slash-and-burn agriculture. Another 7% or 10,000 square km per year were deforested by poor people searching for fuel wood. Forest clearing for cattle ranching, mostly in Brazil and Central America, took another 15,000 square km per year.

It is important to note that the role of poverty-fueled shifting cultivation in deforestation has been increasing, while the relative roles of logging and cattle ranching have been declining. Nearly 1.4 billion people in the world live in absolute poverty. A third of these are landless poor engaged in destructive forms of shifting cultivation. Their number is growing, so we should expect growing damages from shifting cultivation.

The point: so called "solutions" to tropical deforestation that do not take into account the needs of the poor and the landless are no solutions at all. Rather, they are further cruel jokes on the poor. In forestry, fishing, agriculture, or natural resource extraction, poverty is, of course, far from the only culprit in natural resource degradation.

Let us look again at two prime shortcomings undercutting sustainable development. Market failure and policy failure has both been important. Here is a little recognized source of market failure affecting the environment. Market failure with environmental degradation arises when valuable services provided by an ecosystem are not traded in markets. For example, intact tropical forests provide a wide range of vital, but non-traded ecological services. These include watershed protection through control of runoff, soil protection, micro climate control, and protection of animal habitat. But these vital services are not priced, in any existing market. So, as you would expect, are over-used (wasted). There is no market for them. This is market failure.

But market failures, whether due to monopoly, externalities, free riders or transaction costs, now involve few mysteries. They have been studied for many decades by economists, at mind-numbing length. While it has been long recognized that market failure accounts for an important part of environmental degradation, it is now much more widely appreciated that policy failures, or government failures, have also loomed quite large in destruction of the environment.

Also note well: one does not solve environmental problems only with environmental policies. One of the prime causes of policy failure leading to needless ecological and economic damage has been a widespread tendency of policy-makers to ignore the environmental consequences of non-environmental policies. It is still not widely recognized that policies intended primarily to attain non-environmental goals often have very large impacts upon the environment. Non-environmental policies, as we noted, include tax policy, exchange rate policy, industrialization policies, credit policy, and agricultural and food price policies. In much of Africa, Latin America, and Asia a by-product of pursuit of agriculture, energy urbanization, and industrial policies has been significant, corrosive effects upon soil endowments, watershed management, water quality, coastal fishing, and coastal reefs. So, it is not enough that nations follow sensible environmental policies. Greater attention to the environmental impact of non-environmental policies and development projects is required as well, not only for more efficient resource use, but also for equitably distributed growth. Ecological disasters are almost always economic disasters too; in low-income countries the reverse is often true as well. Economic disasters leading to ecological disasters are well illustrated by the experiences of Rumania, Bulgaria, Hungary, and Albania from 1945-1993 when they were Socialist states.

There is much evidence for this. Little imagination is required to see that measures that reduce the environmental damages of non-environmental policies are both good ecology and good economics. And we cannot stress enough that in poor countries policies that help to overcome poverty are also both good economics and good ecology.

A second, not unrelated, reason for policy failures that damage ecological and environmental values has been a persistent lack of understanding of the role of the market and the role of prices in resource conservation, and in ecological protection. An unusually high proportion of policy failures are traceable to short-sighted government subsidy programs that deeply underprice water, soils, forest, and energy resources. Perfect example: public lands in U.S. West are, in some states, more than 50%-owned by the U.S. Government. Government has historically charged extremely low prices for grazing leases. What do you get? Cow-burnt pastures from over-grazing. The government has been a very poor steward of publically-owned lands.

Everywhere, governments and even firms persist in under-estimating the role of market prices in resource conservation or in resource allocation generally. Few in government understand that good economics is good ecology. And the reverse is also true.

But it is not only government that fails to understand the market. Consider for example, another recent United States example outside of the environmental area: pricing of Internet access. A few years ago, America Online adopted a pricing mechanism that involved a flat fee for Internet service: this amounted to a zero price for overuse of scarce Internet access. So, the price of incremental use of the service became unrelated to intensity of use by the subscriber. And the managers were actually surprised when the scheme resulted in catastrophic collapse from overuse.

Consider two policy failures that result from deep underpricing of two vital natural resources – tropical forests and energy. Later we will focus more generally on forests, energy, water and fisheries.

Quite apart from the effects of poverty, policy failures in forestry have been especially destructive to ecological and economic goals in dozens of tropical countries. Brazil's government long provided heavy subsidies to ranching and other activities that encroached heavily on the Amazon rainforest. Thousands of square miles of the Amazon was deforested for two decades. When pastureland replaced the rainforest there were several unintended effects. Few understood that one of these was that the converted pastureland would support cattle for less than five years. Another unanticipated effect of subsidized cattle ranching was that it destroyed rainforest occupations that provided more jobs than were created by subsidized ranching operations. Nevertheless, the Brazilian government made deforestation as cheap as possible. Government policies provided new ranches with fifteen-year tax holidays, tax subsidies, exemptions from export taxes and import duties, and loans with interest substantially below market rates. In Brazil, although a typical subsidized investment in cattle ranching yielded a loss to the economy equivalent to 55% of the initial investment, heavy government subsidies allowed private ranchers to earn a positive return equivalent to 250% of their investment, while the forest was relentlessly destroyed. This was environmental and economic disaster, like ethanol from corn in the U.S.

Most tropical countries including Indonesia, Philippines, and many African nations have charged very low fees for cutting timber on government land. Virtually all impose inadequate timber royalties too low to encourage conservation. Thailand's forestry policies were so wanton that its rainforest has all but disappeared. The same can be said for the Ivory Coast and Gabon in Africa.

Energy pricing provides an altogether frightful history of policy failure leading to unsustainable development. In such oil-rich countries as Nigeria, Indonesia, Iran, Venezuela, and oil poor nations such as Pakistan and Bolivia, domestic use of energy has been kept artificially cheap for several reasons:

1) the widespread view that these subsidies protect the poor, and

2) as a misguided stimulus.

This has had multiple adverse effects on the ecology and on the economy. First, these subsidies encourage altogether excessive wasteful domestic consumption of gas and diesels, thereby reducing the country's petroleum and gas reserves and its export earning potential. As a result Indonesia, an original OPEC member is now a net-oil importer. Second, underpricing of energy artificially promotes the use of auto transport, adding materially to urban congestion and air pollution (India, Pakistan and Mexico City). Third, artificially cheap energy promotes industry that was ill suited to the needs. With very cheap energy, firms and consumers have little incentive to adopt energy-saving technologies. Thus, on several counts, underpricing of energy contributed to environmental degradation, as well as very sizable economic losses.

Indonesia’s kerosene policy furnishes an instructive but sobering example. For decades the government heavily subsidized the consumption of kerosene and other fuels. This subsidy was truly perverse, ranking with the U.S. subsidies to biofuels made from corn. The ethanol subsidy (tax credit) is actually intended to reduce carbon emission. But in fact, it increased carbon emissions by 5 million tons per year in the U.S. The Indonesian kerosene subsidy was actually thought to be justified as a way of both reducing environmental degradation, and especially to aid poor rural dwellers, who used kerosene for cooking. Heavily subsidized kerosene prices were seen as a disincentive to the cutting of fuel wood which was denuding mountain slopes and causing major soil erosion on Java, Indonesia’s most densely populated island. This was a totally misplaced subsidy. Careful research has shown that rural families used kerosene predominantly for lighting, not for cooking. In any case, only 50,000 acres of forestland was protected each year by the subsidy, at a cost of almost U.S. $200,000 a year per acre. Replanting programs, in contrast, cost only $1,000 per acre. The government could have saved 95% of the subsidy by replanting programs. Moreover, 80% of kerosene turned out to be consumed by the relatively wealthy, not the poor. And, another example of how careful one must be in dealing with economic policy issues: the low price of kerosene made it necessary to subsidize diesel fuel as well. Why? Because the two fuels can, to an extent, be substituted in truck engines. Kerosene is used in diesel engines, however, cause even more pollution there than diesel in diesel engines - resulting in greater environmental damage. The multiple costs of this policy finally led the government to sharply reduce its subsidy on kerosene.

Many other nations subsidize kerosene. On my first visit to Pakistan in 1977, I said to my host on the way in from the airport, “I see that you subsidize kerosene heavily.” He replied, “How did you know?” My response: Billows of sooty smoke from truck engines using subsidized kerosene instead of the much more expensive (unsubsidized) diesel fuel.

In a later module the issue of energy subsidies is taken up in more detail. There, we examine these subsidies for Ghana, Philippines, India, Iran, Egypt, Indonesia, Mexico and many other nations.

Mistaken energy policies are principally, but not wholly, to blame for very high per capita rates of domestic energy consumption in countries like Colombia, Bolivia, and Venezuela. As late as 2014, Venezuela priced gasoline at less than 10 U.S. cents a gallon. The environmental consequences of underpricing of energy were particularly notable in such formerly communist command and control countries such as Poland, Bulgaria, Hungary, Czechoslovakia, and Romania, where markets played very little role in resource allocation, until quite recently. Consequently, air and water pollution in these nations were among the worst in the world. As we noted, in Poland the Vistula River was too polluted to use water for industrial use, well water in rural Czechoslovakia was so toxic that bottled water had to be brought in for the population.

Another example of policy failure affecting the environment is many agricultural subsidies. These have not only been expensive, but strongly, and strangely, counterproductive. This was the case for very heavy pesticide subsidies in Indonesia in 1980s. The pesticides were intended to kill the brown-leaf hopper which ravaged rice crops. Not only were overused pesticides damaging the environment, but also they were ineffective. The big crop there is rice. But, heavily subsidized pesticides actually increased infestations of the brown leaf hopper. Why? Because of the greater effects of the pesticides on the natural predators of these pests. The Indonesian rice crop failed in 1979 because of pesticide subsidies. Predators of the hopper were all killed.

In the face of ongoing market failures and ubiquitous policy failures, is sustainable development in poor nations an attainable goal? The answer is a qualified yes, provided attention is strongly focused upon rectifying both market failures and policy failures that corrode sustainability, and upon measures to reduce rural poverty.

The Malaysian case is instructive. This is a country that contains ample contemporaneous examples of both sustainable and non-sustainable development. West Malaysia is separated from East Malaysia by nearly 400 miles of ocean, in the South China Sea. West Malaysia consists primarily of the Malaysian Peninsula, while East Malaysia includes the two states of Sabah and Sarawak, on the Northern part of the island of Borneo.

After an inauspicious, largely wasteful start earlier in the 20th century, West Malaysia has enjoyed mostly sustainable development for nearly five decades, because it finally successfully capitalized upon its initial natural resource base. Real economic growth was in excess of 3% annually from 1965-1990 and has been nearly 5% since. This rapid growth has virtually banished rural poverty as a cause of deforestation and other environmental degradation. Moreover, the environment in Peninsular Malaysia has suffered only lightly from policy failures.

Sabah and Sarawak in East Malaysia had, if anything, an even richer natural resource base per capita than West Malaysia. But for Sarawak after the mid-1980s and Sabah from late 1970-2000, development was unsustainable. Sustainable development in Sarawak has been plagued by the scourge of rural poverty, while in both Sarawak and Sabah, natural forest endowments have been rapidly depleted by unsustainable practices, largely as a result of very serious policy failure, particularly through grossly misguided forestry policy.

In any case, the answer to the question: Can Economic Development Be Sustainable? is yes, for any country that pays appropriate attention to resource scarcity, avoiding artificially cheap prices for natural resources and environmental services.

But the answer becomes much less certain when we consider global sustainability, for the entire planet. The Malthusians are still with us, insisting that growth cannot be sustainable.

Good economics offers hope. In the short term a portfolio of policies can make incremental progress in rectifying market failures leading to environmental degradation. And in the short and long term much can be done to reduce damages from policy failures. If so, one major feature of a strategy for global sustainability would be to move quickly towards more effective markets, so that real resource scarcities will be reflected in the prices people pay for all commodities and services. An end to underpricing and heavy subsidies on fuels, fertilizers, pesticides, water, timber, land clearing, and other destructive uses of resources would be major steps towards sustainability. Most countries are far from this ideal market environment. They could easily reduce resource wastage without jeopardizing economic growth, through better policies, better pricing of scarce natural resources, in some cases judicious reliance on privatization, and above all, measures to reduce poverty, especially in rural areas.

Principal Causes of Environmental Degradation in Emerging Nations

The prime causes of environmental degradation in emerging nations fell into six broad categories. The six modern horsemen of this apocalypse are:

1. Poverty, especially rural poverty (as already noted)
2. Ignorance (scientific ignorance, economic ignorance)
3. Institutions (especially defective property rights)
4. Market failure, discussed generally earlier
5. Public failure, or policy failure, also discussed generally earlierand now a new one
6. Green backfires – unintended consequentials of some environmental policies.

We have and will often refer to these six categories. It will be helpful to examine briefly the role of each in stifling sustainable development.

Consider Indonesia and Brazil as case studies. Indonesia in 2009 had 230 million people, 4th most populous in the world, just behind the U.S. and just ahead of Brazil. Brazil per capita income was $8,000. Indonesia GNP per capita in 2007 was $2,230 or 1/4 the world average of $8,741, and only 4% of U.S. per capita Y (47,240). Per capita income in Indonesia grew 8% year 1971-1996, then stalled, then recovered somewhat.

Indonesia presents a large array of examples of environmental problems traceable to poverty, ignorance, institutions and policies. Many of the examples of environmental degradation observable in Indonesia are consequences of several causes interacting together. Poverty, for example, plays some role in almost every instance. Let us however, group each problem under what appears to be the principal cause.

Poverty

Examples in this category include river pollution, the degradation of coral reefs in Bali, the extinction of the Java tiger, and especially tropical deforestation. Without doubt, shifting cultivation and “shifted cultivators” driven by poverty, is one of the leading causes of deforestation in a country initially blessed with abundant natural forests, second only to those of Brazil.

Consider river pollution. Some years ago, there was a case wherein a British company was discharging noxious, but non-toxic wastes into a river in a poverty-stricken region in West Java. There was strong local political pressure to either close the plant or to drastically curtail its discharges. Closing the plant would have cost over 150 jobs, in a country where growth in the age group 15-30 was far outstripping the number of jobs available. The Government made a decision not to close the plant. Why? To protect 150 jobs? No, because the river was already so polluted from other sources, such as human waste and runoff of heavy fertilizer use, that closing the plant would have had no effect at all upon making the water usable for drinking or agriculture. Sacrificing 150 jobs for zero ecological benefit would have been bad economics, bad ecology, and bad ethics as well. The solution to this environmental problem lay first in efforts to reduce poverty, not environmental policy per se.

Consider however, another river pollution case in West Java not settled by analysis. In 1984 a Japanese plant was discharging noxious waste into a river. Villagers protested: government ignored. Villagers waited another year. Nothing. The villagers burned down the plant.

Coral reefs surround and protect a large part of Sanur beach on eastern Bali, Indonesia. The Island of Bali is very densely populated. Poor families have long harvested coral between the reef and the beach. The coral was used as a binding agent in making a particular form of durable cement. As a result of coral harvests, the reef was being slowly destroyed. As a result, erosion was threatening not only the beaches, coastal ecology, but thousands of jobs in tourism. What to do? Some foreign experts recommended construction of jetties to protect the threatened beaches from erosion. This does not work in Bali any more than it works on the east coast of the United States. Others advocated banning the harvest of coral. But this would have resulted in loss of livelihood affecting perhaps 4,000 people all poor. If coral gathering were banned, how would these people survive? Is a job in the tourist industry worth more than two or three jobs in coral gathering? This involves both economic and ethical questions. And what if the degradation of the reef is now so advanced that it is too late to save it by prohibiting coral harvests? So this is also a difficult ecological question. There was no good solution to this poverty-induced problem.

Finally, consider the extinction of the Java tiger. Habitat for these beasts has been so constricted over the past half century by population pressure and poverty-driven fuelwood harvests that, at most, two were left by the year 2000. Now the Java Tiger is considered extinct.

Ignorance

Ignorance, or better said, the absence or inaccessibility of good scientific and ecological information, underlies much environmental degradation in Indonesia, just as elsewhere.

Ignorance about key determinants of the fragile ecology of tropical forests prevented Indonesia, Brazil and other countries from knowing how to utilize the renewable products and services of natural forests in a sustainable way. Some countries, fortunately not Indonesia, do not even keep statistics on the value of production and exports of the non-wood forest products that can be harvested without cutting down trees. These non-wood products include food for both plants and animals and traditional medicines from forests such as herbs, vines and drugs.

Catastrophe and the Role of Ignorance: Tropical Forestry

Very large scale exploration of tropical forests began only in 1946 first in the Philippines, amidst virtually complete ignorance of ecology of the tropical forest. It is now widely recognized that this ecology is fragile and complex, but otherwise not much ignorance about it has been dispelled. Even now little is known about such vital ecological issues as what happens in regeneration of cut-over or cleared stands, flowering and fruiting in the natural forest or the role of forest animals in seed distribution. This is because some tropical trees flower only at 30 year intervals. This is not irrelevant in efforts to understanding forest ecology.

Second, a high degree of ignorance remains regarding the effects of human encroachment upon natural tropical forests. This is because information on the economic as well as the environmental impact of the forest utilization is grossly incomplete and deeply flawed. We will see that these flaws are particularly glaring in systems of national income accounting used by all nations. Consequently, there is a clear bias in decisions about forest utilization, in favor of activities most corrosive of the long-term value of tropical forest assets. We will discuss this later.

The problem has not been confined to Indonesia. And as noted earlier, until recently ignorance was almost total everywhere regarding the fertility of deforested tropical timber land. Now, we know in Brazil that such soil has the color of cement, and is not much richer in nutrients than cement.

Brazil's Forests

There are many lessons to be learned from Brazil’s experiences with its' tropical forests since 1960.

Brazil’s tropical forests are the largest on earth.

Consider the distance between Chicago and Juneau, Alaska. This is the size of the Brazilian State of Amazonas, almost all of which is or was forest. But Amazonas contains only part of the forest: there were also very large forest areas in the adjacent states of Para, Amapa and Mata Grasso.

For about 3 decades, deforestation raged in Brazil, but there was mostly studied ignorance about it among Government officials in Rio de Janeiro and Brasilia, the nation’s capital.

Between 1980 to 2006, 17% of the forest vanished.

Put into perspective, this means that in Brazil, every year a chunk of forest equal to an average state in U.S. disappeared.

Just in 2004, over 16,000 square miles of forest vanished – an area twice the size of Massachusetts. In 2004, at least a billion, perhaps 1.3 billion trees fell to the chainsaw or the bulldozers. [footnote] Even by 2013, about 2,256 square miles of Brazilian tropical forest was lost to deforestation in that one year.
U.S. News, Feb. 12, 2007.

And there are other consequences of ignorance about tropical forests. Consider this statement by T.C. Whitmore in 1975, in his book titled *Tropical Rain Forests of the Far East:*

“Finally it must be noted that many forest mammals, especially monkeys and apes, harbor diseases caused by arboviruses and borne by mosquitoes and ticks, for example dengue fever. When the forest is logged, these diseases are easily transmitted to man and carried by him to urban areas where they can cause epidemics."

Prophetic. [footnote]
T.C. Whitmore, Tropical Rainforests of the Far East (Oxford: Clarendon, 1975).

It is now fairly certain that the AIDS virus, jumped from apes to man in the Central African Rain Forest.

Future Generations

The economies of many nations with significant remaining tropical forest endowments are strongly dependent upon these natural assets. This dependence is much more than a matter of the economic value of wood and non-wood forest products. The spatial dimensions of the protection furnished by intact forests extend not only to adjacent areas and local watersheds, but to faraway water systems and ultimately to seawater, the quality of which is so important to coral reefs and coastal fishing. Soil erosion, siltation, sedimentation, and disruption of water systems arising from deforestation take a heavy annual toll on productivity in agricultural and fisheries. In countries such as Indonesia, the Philippines, Thailand, Costa Rica, and Brazil, this toll also threatens the foundation of jobs and income in tourism, a labor-intensive industry in virtually all countries.

NATURAL CAPITAL: FORESTRY

We continue our discussion of the most important causes of environmental degradation in emerging nations with a closer look at ignorance.

The Role of Ignorance

Natural Income accounting was introduced 70 years ago by Simon Kuznets. It is now used everywhere to provide a measure, imperfect as it may be, of economic welfare comparable across countries.

Use of Natural Income accounts and ongoing efforts to improve them has helped us understand much better how to measure growth and compare growth. But there is one area in Natural Income accounting that has received far too little attention. No country properly accounts for the externalities and social costs often involved in extraction and depletion of natural resources, including forests, minerals, oil and fisheries.

This is a measure of our ignorance about the effects of natural resource use. Natural Resource Accounting can help remedy this deficiency.

Resource Accounting

The terms Gross National Product (GNP) or Gross Domestic Product (GDP), national income, depreciation and personal income are familiar to all economists. The ultimate test for many government policies has been their impact upon the rate of growth of these magnitudes. Again, the conceptual framework from which these broad macroeconomic measures spring is called National Income Accounting, used in the U.S. since 1942. The basic purpose intended for national income accounts is to provide analysts with some measure of performance of the economic system. For what the accounts attempt to measure, they do a reasonably good job of measuring, in spite of still sizable errors of omission as well as remaining conceptual issues: especially the impact of government investment.

The system of national accounts in use by virtually all countries suffers, however, from a much more fundamental flaw that has serious implications for prospects for sensible environmental policies: the system greatly distorts the role of natural resources in economic processes. This distortion has two principal dimensions. First, present systems of national income accounting fail to recognize natural resources as economic assets. Second, the protective services provided by these assets are not valued. However, the additional expenditures forced on society by the loss of these services are valued. Thus, systems of national income accounts are laden with harmful paradoxes. The depreciation of man-made capital equipment and infrastructureis recognized as a cost in the national income accounts. But the depletion of soils, minerals, hydrocarbons, and forests is not. As a result, there is a perilous asymmetry in the way we measure, and therefore the way we think about, the value of natural resources. This asymmetry gives rise to patently anomalous, and uneconomic, practices. Consider this: on the one hand, the treatment of government expenditures for cleaning up the catastrophic oil spill in 2010 in the B.P. oil spill in the Gulf of Mexico. These clean-up expenditures added to the nation’s gross national product. This is so even though the affected waters, sea life and tourism were severely harmed. On the other hand, a country could exhaust all of its forest resources and, in the process, silt up all its rivers and harbors, but measured national income would be reduced only when these resources vanished. To put the problem another way, consider a country that for several consecutive years experienced depreciation of its man-made capital stock in excess of new investments in physical capital. That country would soon suffer a decline in its measured National Income, because physical assets would wear out at a faster rate than they were being replaced. Policymakers would have a very clear signal that something was seriously wrong. But a country such as China, or Nigeria, or Venezuela drawing down on its natural resource base, by mining, drilling or logging, may enjoy high rates of GNP growth for long periods, even in the absence of any new investments in sustaining the stock of these natural assets. Under prevailing systems of natural income accounting, the economy’s health would appear quite robust during the draw-down. Therefore, the liquidation of man-made assets shows up in the national income accounts as economic decline; the liquidation of productive assets provided by nature shows up as economic growth.

This defective system of information provides defective signals to policymakers. These signals lead to policies that destroy, or at best, ignore, values of the environment in order to secure illusory and/or unsustainable short-term gains in measured income, that register as additions to GNP. Clearly then, a high premium should be placed upon incorporation of concepts of natural resource accounting in the national income accounting frameworks of all nations, tropical or otherwise. The technology for doing so is known, the data requirements are not all that great, and the costs are not huge. But so far, few countries use resource accounting.

Institutional Failure

Institutional failure has been a third fundamental factor in environmental degradation generally, and tropical deforestation in particular. To review: “Institutions” can be viewed in two principal ways. First, institutions can be “rules of the game,” or policies governing decision-making by individuals in their capacities as producers, consumers, risk-takers, or voters. Second, institutions can be organizations, especially public organizations or agencies affecting the operation of the economy. Institutions affect individual and social choices in several ways by shaping incentives, by influencing the availability of information and resources, and by establishing the basic rules of economic and social transactions.

Our primary focus in this volume is upon economic institutions.

These include, as we have seen, systems of property rights, inheritance laws contract systems and law enforcement. They include markets such as those for capital goods, and labor markets, which mediate the interaction of supply and demand. They also include public economic organizations such as government departments and SOE^s. In many instances, environmental degradation can be traced directly to the failure of such institutions.

Armed with this knowledge, we may focus more closely on some critical aspects of tropical deforestation. In the process we may acquire an enhanced basis for thinking about a much wider range of environmental issues such as erosion, water pollution, and wildlife management.

First, consider what deforestation[footnote] in the tropics means:
For a synopsis of the evolution of Foreign Trade in Tropical Hardwoods and Deforestation in Southeast Asia, see the Appendix to this chapter.

Deforestation refers to the destruction of forest cover, whether this destruction is due to land-clearing for cattle ranching, small holder agriculture, plantation agriculture, or parking lots. Deforestation means that the land is converted permanently from forest uses to non-forest purposes. Deforestation is much more serious than forest degradation. Forest degradation may alter the ecology of a forest parcel, but does not destroy all forest cover. Logging is one of the main direct causes of forest degradation in many countries. But only in a very few nations has logging been as destructive as to be a direct cause of deforestation. In other nations, logging has indirectly caused deforestation, by opening up remote areas of the forest for agriculture and making the forest more vulnerable to catastrophic fires, as we shall see.

Now consider the institution of property rights in natural forests, the "common property problem" and the inadequacy of rules of land tenure for disturbed forests. Throughout the tropics, central governments have appropriated property rights to vast areas of forest from local peoples. We noted earlier that more than four-fifths of the world's tropical forest area is owned by governments, rather than by local people most knowledgeable about forest ecology. Central governments head-quartered in distant capital cities have proven insensitive to the economic and social benefits of maintaining the productive services of the forest. These include wood and non-wood forest products. Central governments also have almost completely ignored the protective services: regulation of run-off, control of floods, curbing of erosion and provision of animal and plant habitat in intact or lightly perturbed forests. Since central governments in many developing nations have generally lacked the means (and often the interest) to enforce forestry regulations in remote regions, local peoples have often been powerless to resist opening up access to the forest for virtually uncontrolled exploitation. The forest then becomes an open access or common property resource, an institutional arrangement, leads to the familiar "tragedy of the commons," a phenomenon present in the degradation of the almost all common property, including the atmosphere and the oceans, especially fisheries. Basically, the common property problem is this: what is owned by everyone is owned by no one, so that incentives to conserve and improve common property are absent or extremely weak.

Institutions of land tenure also impinge upon the tropical forest. For example, in Ecuador and Brazil destruction of natural vegetation has usually been a prerequisite for securing formal tenure in a colonized parcel. Even where property rights to the forest are well-defined and can be held by local peoples, the rights are often insecure. When property rights are insecure, owners will not make improvements or protect the soils of cleared land, and why? Because if they do, there is no guarantee that they can capture the benefits of improvements.

From this discussion, we may conclude that property rights consistent with sustainable development have five features.[footnote]
See Malcolm Gillis, Dwight Perkins, Michael Roemer, Donald Snodgrass, Economics of Development, Third Edition, 1992, p.540-41.

They must be:

1. Well defined
2. Exclusive
3. Transferable
4. Secure
5. Enforceable

If these conditions are met, then owners can recover costs of investment made in protecting the value of the resource, and therefore face the right incentives.

Some tropical governments have begun to pay greater attention to the "common property" problem and to the role that well-defined and secure property rights can play in reducing deforestation. It is important, however, to note that solutions to common property problems do not necessarily imply shifting land rights in forests from governments to individuals. For example beginning in February

1990, Columbia returned land rights to half the Columbian Amazon region to local Indian tribes groups. On the other hand local tribes such as the Ashanti once had ownership of forests in Ghana. They protected it because it was theirs. But after the central government took over these property rights in 1960s, massive deforestation ensued.

Early in the 21st century, Peru has followed suit with measures similar to Columbia. There has also been progress in Brazil on institutional change affecting the tropical rainforest. In 2009 the Brazilian government announced a new program to regularize the titles (property rights) of 80% of formerly insecure private land holdings in the Brazilian Amazon. One of the best things Columbia ever did was to establish in fifties a central registry for land titles. A big problem was that Brazil lacked a central land registry, so widespread forgery of deeds, insecure property rights were common.

The reforms in Brazil included:

1. Transfer title to the land outright to people already farming it, up to 500 acres
2. For larger plots of land (500 to 5,000 acres), sell the land using various pricing mechanisms
3. Finally, the government reclaimed lands over 5,000 acres

It is still too soon to tell whether the reforms will help stop the pillage of the forests in Brazil? Perhaps, but it is a good start.

Market Failure Reconsidered

For most of the past 25 years, market failure has been the most studied form of institutional failure leading to environmental degradation in tropical forests and elsewhere. We have noted markets for many environmental services – clean air and water, soil conservation, preservation of climate – either do not exist, or function poorly. We have seen how open access - lack of property rights to forest land can promote deforestation. But market failures also arise from other sources:

a. monopoly and oligopoly power,
b. what economists call externalities, and
c. public good effects.

Consider externalities. Deforestation, whether caused by land-clearing for agriculture fuelwood gathering, or by logging, involves also sizable external costs in the form of diminished watershed protection, soil erosion and sedimentation, and increased vulnerability of the forest to disastrous fires. These costs can run into the billions of dollars for a particular country, as in disastrous forest fires in Borneo in 1983. This conflagration illustrates both market failure and public failure. It is important to understand that logging activities in Indonesia, and in particular Boneo, involved selective cutting, not clear cutting of trees. Because of this, logging activities left significant ground litter, easily combustible.

Between January and May in the severe drought year 1983, a voracious fire spread over millions of hectares of moist tropical forest in northeastern Kalimantan. This conflagration was not only a cause of very wide-scale deforestation, but a consequence of forest degradation as well. Forest fires on Borneo have frequently occurred during periods of severe drought over the past century, but never before on the scale, duration, and intensity as that of 1983. The 1983 Borneo fires qualify as one of the greatest peacetime ecological calamities of the century. By itself, the great Borneo fire caused massive destruction.

How was the Borneo 1983 fire an example of market failure? Understand that large-scale selective logging on Borneo began only in 1969. Logging involved an unforeseen externality. Destruction from the 1983 fire was particularly severe in the logged-over areas. Indeed, in East Borneo the unlogged forest escaped major damage. But in logged-over areas, there was a great amount of dead wood and other combustible ground litter. In areas logged, up to 50% of the residual stock left after logging was destroyed or damaged. With all that fuel on the ground, the fires thus were able to burn at very high temperatures. Airplanes flying over Borneo at 35,000 feet were enveloped in smoke from the fires.

The huge Dipterocarp trees that had been left standing after logging exploded like roman candles in the fire, shooting flames straight up 500 feet. Many local populations of hornbills were exterminated. Have you ever heard a hornbill in flight?

Damage was very slight in undisturbed unlogged forest areas because of the relatively low volume of dead wood and other ground litter prevented fires from generating enough heat to ignite the large Dipterocarp (Meranti) trees.

The base cause of this catastrophe was that Government sold the resource too cheaply, and logging after 1970 predisposed the forest to catastrophic fire. Vulnerability to fire was a very large external cost not reflected in either the prices paid by loggers for logging rights, or the prices paid by consumers in the U.S. and Europe for tropical wood products. Even if the government as owner of the forests had recognized the risks of greater forest vulnerability from logging, and even if they had sought to charge a price for wood high enough to cover these costs, there was no way for the market to value them. Market failure thus contributed to ecological calamity, a giant external diseconomy- a cost – imposed on others by economic actions of a few.

Another very large externality of deforestation has been an increase in CO^2 emissions. Deforestation accounts for 20% of annual worldwide emissions (This includes carbon emissions from burning fossil fuels and deforestation). In 2010 Brazil and Indonesia were #3 and #4 in total emissions, right behind #1 China and #2 U.S.A. How can this be? About one half of the weight of a tree is made of stored carbon most of which is released when trees rot, or are burned. An equal or greater amount of carbon can be released from the soil following deforestation, further contributing to rising atmospheric CO_2 levels.

Faulty institutions also played a role in the catastrophic Borneo fires of 1983. How?

Satellite pictures taken in January 1983 showed no fire.

Satellite pictures taken in February - March showed the fire raging.

Satellite pictures in April showed only burnt out forests.

But by May of 1983, the President and Cabinet in the capital of Jakarta knew nothing of the extent of the fire. They found out only in May when shown the satellite pictures. The reason they were unaware of the catastrophe was due to a common worldwide cultural trait that is especially important in Indonesia.

The President was not told about the fire while it raged across Borneo. Why? There is an old Indonesian saying:

Sedang Bapak Senang

“Don’t bring bad news to the boss”.

Is this true elsewhere? Yes, it can be true in industry, in government, in universities, worldwide.

The role of government failure or policy failure in tropical deforestation surely rivals that of market failure. In Indonesia, Brazil and other tropical nations a battery of government policies, including those adopted for worthy objectives, have played a large and hitherto unappreciated role in creating economic incentives that have severely aggravated the extent and severity of deforestation in the tropics. These include both forestry policies and, significantly, non-forestry policies. Government forestry policies, including royalty and timber concession policies, have grossly underpriced the resources of the tropical forest. This has resulted in unmistakable perverse signals to loggers, ranchers, and agriculturalists that natural forest resources are cheap and may be freely wasted.

Non-forestry policies are those that, intentionally or not, have a significant perverse impact on forest utilization, but which are primarily intended to further non-forest objectives. Such policies include tax, trade, monetary, exchange rate, and food policy. General tax policies have subsidized deforestation by offering large income tax incentives for investments in logging, timber-processing, and land-clearing activities for estate crops and cattle ranching. The effect was to make deforestation attractive to firms. Timber booms in the Philippines, Malaysia and Indonesia were fueled by generous income tax exemptions for logging and for processing plants, as well as by sale of timber from government-owned land at prices well below market.

Financial policies involving credit subsidies added to quite perverse incentives for forest investments in Indonesia, Ghana, the Philippines, and especially Brazil. Artificially low interest rates available for finance of logging activities and for forest-clearing projects for large-scale cattle-ranching in 70s, 80s, and 90s by themselves produced very powerful incentives for destruction in the Brazilian Amazon. When coupled with tax subsidies, the incentives for very large-scale forest clearing proved irresistible, so that intrinsically uneconomic cattle ranches in the tropics, particularly in Latin America, have generated large profits for investors. This demonstrates how land-clearing for cattle-raising in Brazil has been not only an ecological catastrophe, but a fiscal and financial catastrophe for governments.

This was also true for heavy subsidies to plywood mills in Indonesia, which created irresistible incentives to cut down forests. This particular non-environmental policy led not only to environmental losses, but to huge losses to the government budget. The Indonesian plywood subsidy stemmed from an understandable desire by government officials to get more domestic value-added by encouraging export of timber in the form of plywood rather than as logs.

Similar subsidies have been used in Oregon in U.S. On first examination, this seems like a worthy goal. We will see. Again the law of unintended consequences, of policies.

The Indonesian plywood subsidy to plywood made from tropical logs resulted from having a high tax on logs and a zero tax on plywood.

Export tax on logs – 20% per cubic meter (m^3)

Export tax on plywood – 0%

Why is this a subsidy to plywood makers? It heavy protection to domestic plymills relative to foreign plywood producers, who have to buy logs from Indonesia that have paid the 20% tax.

1 cu meter log export at $100 m^3 yielded $20 in export taxes for the government. But there was zero tax on logs sold to Indonesian plymills, and zero tax on plywood exports.

1 cu m plywood exports at $250 m^3 = zero export tax.

Government official looked at the difference between 1 m^3 of log exports and 1 m^3 of plywood exports and mistakenly concluded that it was obvious that a subsidy (zero export tax on logs) was justified, because of the much higher apparent value of plywood exports. They observed that at a time when they could export logs at 100 m^3, you could get $150 per m^3 for plywood. They overlooked the fact that you lose a lot of wood in converting logs to plywood.

In any case by encouraging plywood, not log exports, Indonesia sought to secure $150 per m^3 in more Domestic Value Added, for each m^3 of logs used. If true, with plywood exports per year at 10 million m^3, then Indonesia would have a total of $1.5 billion in extra Domestic value Added. Case closed.

A good subsidy? Did it achieve the desired results? This is yet another case in economics where things are not as they seem to be. Why? The policy-makers and their World Bank advisors ignored the fact that Indonesian plymills were very inefficient because they were subsidized. They were inefficient, and did not minimize costs.

In Japan, recovery rates for converting Indonesian logs into plywood were 55%. Therefore one m^3 of log would give you, when processed, 0.55 m^3 of plywood in Japan.

But in Indonesia, recovery rates were only 43.5% - i.e. One m^3 of log would give you only 0.43 m^3 of plywood in Indonesia's plymills.

Consider – Wood exported as a log fetched $100 m^3 and brought in to the government export tax revenue of 20% ($20) per m^2. The total value to economy was then $120 per log exported. Consider the same timber as the log, but processed in plymills and exported in plywood form: 1m3 of log converted at 43.5% gives you .435 m^3 of plywood valued at $250 per m^3. This is 108.75.

So, Indonesia did gain $8.75 per m^3 of Domestic Value Added when wood was exported as plywood, instead of logs. But, Indonesia lost the 20% export tax it would have collected on the wood exported as log. That would be $20. So, the net gain to Indonesia was negative: i.e.

-$20.00 Lost export tax per m^3

+8.75 gain in Domestic value Added

This is a total Loss of $11.25 per m^3 to the Indonesian economy, and a total subsidy to plywood producers. Ask yourself, is this a good thing? Things are not always what they seem in economics. [footnote]
See Roberto Repetto and Malcolm Gillis, Public Policies and the Misuse of Forest Resources, Cambridge University Press, 1988.

Future Generations

The economies of many nations with significant remaining tropical forest endowments are strongly dependent upon these natural assets. In forestry, this dependence is much more than a matter of the economic value for wood and non-wood forest products. The spatial dimensions of the protection furnished by intact forests extend not only to adjacent areas and local watersheds, but to faraway water systems and ultimately to seawater, the quality of which is so important to coral reefs and coastal fishing. Soil erosion, siltation, sedimentation, and disruption of water systems arising from deforestation take a heavy annual toll on productivity in agricultural and fisheries. In countries such as Indonesia, the Philippines, Thailand, Indonesia, Costa Rica, and Brazil, this toll also threatens the foundation of future jobs and income in tourism, a labor-intensive industry in virtually all countries.

Shortages of Tropical Forests

Except in a few very low income, and not incidentally, already heavily deforested nations, present and future generations face no shortage of wood. But, continuation of present rates of degradation and deforestation does mean that both present and future generations confront a critical shortage of tropical forests, involving needless destruction of both important tangible economic values, as well as ecological and equity values. Moreover, all indications are that continued shrinking of the world's tropical forests estate involves sizeable risks of destruction of other important social, biological, and intangible economic values ranging from heightened erosion, loss of productive habitat, both for traditional human forest dwellers and for forest creatures, to climate changes, loss of bio-diversity, as well as extinction of particular species.

Destruction of Tangible Economic Values

Popular discussions of the global tropical forest dilemma often focus upon a supposed clash between economic, as opposed to broader social, values in tropical forest utilization. Positing the problem in this way is appropriate in one limited sense only. Some types of economic returns from forest conversions are not only tangible, and easily measured, but can be easily appropriated by loggers and agriculturists large and small. However, many of the real costs of generating these returns are neither easily assignable to the extractive activities, nor are they clearly apparent. But other types of returns from leaving tropical forest assets intact are not easily appropriable, and are much more intangible. Many of these returns are manifestly economic in nature and stem from both the productive and the protective functions of the forest. It may be seen, then, that quite apart from any clash between more tangible and measurable economic values and broader, less tangible social values in decision-making on forest land use, recent patterns of utilization of natural forest involve conflict among economic values as well. There is conflict on the one hand between considerations of the economic value of wood and land-clearing for crops and cattle, and on the other the economic value both of non-wood forest products, and of the palpable, yet not readily measurable economic value of soil and watershed protection furnished by intact forests. In virtually all countries with tropical forest endowments, this conflict consistently has been resolved in favor of the former, narrower, set of economic values.

Examples are plentiful. In dozens of nations from Southeast Asia to Africa, the government as owner of property rights to the natural forest has placed far heavier value on the productive rather than the protective resources provided by the forest. Moreover, the natural tropical forest has been exploited as if only two of its productive resources were of any economic value: the timber stands and the generally poor quality agricultural land lying beneath the canopy.

A third economic resource has been consistently overlooked: the forest's capacity to supply income from commercial and non-commercial non-wood forest products. Virtually all important non-wood forest products in the tropics can be harvested without cutting down trees. Commercial products already known number in the dozens, and include nuts, oils, fibers, meat, cosmetic compounds, dyes, fruits, latex, edible birds' nests, ornamental plants, spices, and pharmaceutical substances.

Harvest of these products can provide a perpetual annual stream, of income for local people, while leaving the natural forest largely intact. Destruction of the forest destroys this stream. Logging and land-cleaning in the forest, generate essentially short-term economic returns. Clear-cutting is rarely the problem in the case of the type of selective logging practiced in the tropics (wherein one to three stems per hectare are taken). Long-growing cycles for timber means that the commercial value of a cut-over stand cannot be replenished for more than a half-century, if indeed ever. And in the species rich, finely-tuned ecosystems on poor soils characteristic of many tropical forests, even selective logging does three things to the ecosystem that harvest of non-wood products does not: it damages the canopy and the solid, and results in the removal of large quantities of minerals. In the case of clear-cutting of tropical forest for resettlement projects (as in Indonesia and the Philippines), or for cattle ranches (as in Brazil, Ecuador and Central America), former forest lands cannot generally even generate positive private economic returns without expensive governmental assistance. In the case of land clearing for pastures in Brazil, even very heavy subsidies proved insufficient to keep some ranches in operation beyond five or six years, with similar results reported for Central America.

In the case of logging, it is not at all apparent that for a given forest parcel the economic value of the perpetual annual stream of income from annual harvests of non-wood products is exceeded by the economic value of logs extracted or land cleared. Several recent cases from Indonesia, Philippines, and Peru in fact suggest that the potential economic benefits from keeping natural forests intact may greatly exceed those which results from forest conversion.

Consider first a much-simplified example, taken from Indonesia data. There, I once found that, at least for some areas of forest land, that every hectare logged each year, Indonesia gave up twice as much future income from non-wood products than it gains from logging. This is true even though I applied a 6% rate of discount to the perpetual stream of income from non-wood products, meaning that returns 25 years or more from now have virtually no value. Also, in studying this case, I ignored all the very large environmental costs of logging.

Norman Myers presents a similar example taken from the Bacuit Bay area in Palawan Island in the Philippines. This involved a drainage basin having a mean slope of 30 degrees. Employing a discount rate of 10%, he finds that potential revenues from a decade of continued logging in this area would have a present discounted value of U.S.$9.6 million or only $960 thousand per year. However, continued logging led to a worsening of already serious problems for fishing and tourism arising from erosion, siltation, and bay sedimentation.

In the absence of logging, the fishing and tourism industries in the area could generate revenues totaling $54 million, in discounted present value. With continued logging, however, the present value of revenues from fishing and tourism would be but $21.4 million. Logging, then, will destroy $33 million in economic values in fishing and tourism. Therefore, for each dollar gained from continued logging, four dollars will be lost in the fishing and tourism sectors. Is this very bad economics?

These oversimplified examples are based on a very limited number of cases. Nevertheless, they do suggest that over the past few decades, environmentalists may have erred in focusing so strongly on the social and environmental costs of tropical deforestation, many of which are not easily measurable and which in case have gone largely unheeded by governments. Economic arguments against present patterns of forest utilization are available, and they can be powerful even when the discount rate, so much maligned by many environmentalists, is deployed in the analysis.

Destruction of Equity Values

Western environmental organizations advocating curtailment of tropical deforestation have many critics especially in tropical countries. Critics have charged environmentalists in North America with intellectual imperialism. To these critics, a strong focus on environmental values is often viewed as "a luxury of the rich," that fails to recognize that the need to overcome widely shared poverty in the short term, so, it is argued that the goal of reducing poverty to medium term overrides such longer-run issues as preservation of natural habitats and biological diversity.

These claims merit serious consideration, from the point of view both of present and future generations of tropical peoples, especially landless rural dwellers. Insofar as the current generation is concerned, it is not at all clear that curtailing of tropical deforestation is incompatible with greater equity in the distribution of income. Rather, a case may be made for the argument that the poor may have been bearing a disproportionately high share of the costs, and receiving a disproportionately low share of the returns from recent patterns of tropical forest utilization. That being the case, accelerated conversion of tropical forest justified in the name of the poor would have led to a worsening, rather than an improvement, of the impoverishment of the poor. Let us develop these points.

Costs

First, focus on the present generation. We noted earlier: poor people in poor countries are far more dependent upon soils, fisheries and forests than are the wealthy anywhere. Therefore, degradation of the resource base, particularly that portion which supports food production, involved more serious immediate consequences for the poor.

This is most obviously the case for millions of people, typical cultural minorities, for which tropical forests have been a traditional abode. In the Philippines alone, these numbers have been estimated at six million people. There are, by the way, two general types of forest people, including 1. those already participating in the modern economy, and 2. those in voluntary or non-voluntary isolation from the modern economy and the dominant cultures. The interests of peoples such as these are usually ignored, and liquidation of natural forest assets for the valuable wood or for the extremely limited agricultural potential of the soils lying beneath the forest canopy results in irreversible losses of livelihood for these people and destruction of a way of life.

Tangible, immediate costs to generally poor forest dwellers extend well beyond these losses, and include costs attendant upon increased erosion, greater difficulties in river transport, large-scale forest fires, and flooding that follow in wake of deforestation. These same costs, particularly those of watershed damage, leading to more erosion, impacts millions of marginal farmers downstream. As a result, in nations such as Thailand, both forestry and agriculture have become unsustainable in large areas in the adjacent to farmer forest lands.

APPENDIX TO CHAPTER 13: INTERNATIONAL TRADE AND DEFORESTATION IN TROPICAL HARDWOODS

I. INTRODUCTION

The markets for hardwoods and softwoods are related, but different. Hardwoods ordinarily are denser and more durable; the wood fibers tend to be shorter than softwoods such as pine. However, softwoods, while suitable for pulp and paper manufacture, are not sufficiently durable to be used outdoors unless wood preservatives are applied.

Large scale exports of tropical hardwoods has been a relatively recent development. International trade in wood and wood products prior to 1800 was dominated by exports from temperate zone forests. Typical uses were such items as ships' masts, building materials and furniture. Trade in tropical hardwoods was relatively limited, and consisted primarily of relatively small volumes of wood taken from easily accessible forests in coastal tropical regions in Central and South America, West Africa, Philippines, Thailand, India, Burma and Malaya. However, ship builders imported significant quantities of African oak (iroku) into Liverpool as early as 1823. The history of international trade in tropical hardwoods over the past two centuries may be divided into three distinct periods.

1. 1800-1945: specialty trade in hardwoods prized in furniture and ornamentation, especially teak (first from Burma, then other Asian nations) and mahogany (from Central and South America).
2. 1945-1975: Booming log exports especially from East Asia, West Africa and to a much lesser extent, Central and South America. Tropical logs were shipped primarily to plymills and sawmills in the U.S., Japan and Europe. Two factors were especially notable in this period. First, rapid increases in industrial country demand for plywood and other wood products made from short-fiber tropical hardwoods generally unsuitable for making pulp and paper. Second, the increasing utilization after 1945 of the one-man chainsaw and heavy harvest vehicles enabled log exports on a scale theretofore impossible. Tropical hardwood exports grew rapidly during this period, from less than US $350 million in the mid-fifties to $8.7 million by the end of the seventies.
3. 1975-2010: There were four especially notable developments in this period. First, the dominance of East Asian Nations, especially Malaysia and Indonesia in the export market. Second, there was after 1985 a very sharp increase in exports to rapidly growing China. Third was a steady decline in the purchasing power of tropical timber exports, in spite of steadily rising nominal prices for logs, sawnwood and plywood. This is discussed in detail in Section III. Fourth, there were sharp changes in the composition of tropical hardwood exports. Whereas in earlier periods almost all exports were in log form, by 2010 exports were primarily in the form of processed wood products. By 2007, total export values reached $26 Billion (See Table 13-2).

The evolution of the international market for tropical hardwoods can be best understood by considering the two most salient features of the postwar history of trade in this product. Table 13-1 shows the pattern of tropical hardwood trade by volume (in thousands of M^3) over the past few decades, by region. In 1977, Asia accounted for 82% of all exports. Malaysia and Indonesia together comprised 94% of Asian exports and 77% of world exports. By 2007, Asian exports were 74% of total world trade, while the share of Malaysia and Indonesia in the world total was 62.5% African exports were but 14% of the total in both in 1977 and 2007. Exports from Latin America were neglable in 1977, but notable by 2007.

Table 13-2 portrays the composition and total value of world trade in tropical hardwoods in 2003 and 2007. Total world exports reached $15.7 billion in 2003, and climbed sharply to $25.6 billion by 2007. Interestingly, by the year 2007, average unit export values for African tropical logs reached $199 per M^3, versus only $131 in Asia and $127 in Latin America. This development most likely resisted from a shift in European, Japanese and American consumers preferences toward African wood.

	1977	**2007**
Oceania	1,699	423
Africa	6,549	6006
Asia	37,426	30,870
(Indonesia)	(18,932)	(6,939)
(Malaysia)	(16,118)	(19,143)
Latin America	268	4,374
Total	45,942	41,673
Source: FAO, YearbookofForestProducts1970-81 and 2003-2007 (U.N. Rome) (a)		

Table 13-1 World Exports of Tropical Hardwood, 1997-2007 (Logs, Sawntimber, Veneer and Plywood) [In thousands of cubic meters (m^3)] (a)

A noteworthy feature of Table 13-1 is the relatively small (but growing) share of Latin America in international trade in tropical hardwoods, in spite of the huge expanse of Amazonian tropical forest. In 1977, Latin America accounted for less than 1/10 of 1 percent, by 2007 this figure reached 10%.

While the Amazonian forest includes parts of Colombia, Peru, Venezuela and Bolivia, the forest lies primarily in Brazil. Brazilian exports of tropical timber have not been commensurate with the size of that nation's forest estate. The small share of tropical hardwood exports come from the Amazonian forest has been largely due to two principal factors.

	2003	**2007**
Roundwood	$2.17	$2.03
Sawnwood	3.80	3.31
Wood Panels	5.01	11.10
Veneer Sheets	0.70	0.90
Plywood	3.62	7.61
Other	0.40 (a)	0.65 (a)

TOTAL	$15.71	$25.62
Total Value, Africa	$2.11	$2.79
Total Value, Asia	$11.18	$21.69
Source: FAO, Forest Products 2007Tables 42, 67, 80.95(a) Other = Particle board, wood chips, etc.		

Table 13-2 Export Values, Tropical Hardwoods 2003-2007 Billion, U.S. Dollars

i. The inaccessibility of much of Amazonian forest resources, relative to East Asia and West Africa. This inaccessibility is due not only to the enormous size of the forest, but to lack of transport infrastructure that would enable harvested logs to be shipped or floated to ports or to central processing facilities. While logs have often been floated down rivers in East Asia and parts of West Africa, this is much less feasible in the Amazon basin, where rivers are typically much longer than in the other regions (especially East Asia). Also, some logs are "floaters" and some are "sinkers". While most tropical hardwoods have a specific gravity that allows them to float, a log that is too long in the water suffers sharp downgrades in quality, and water absorption over time causes many to sink.[footnote]
Specific gravity is the ratio of the density of a material (logs) to the density of water at a specified temperature (usually expressed as 4 degrees centigrade). Floaters become sinkers when wood swells when damp. The swelling is due to the presence of atoms (hydroxyl group of atoms) which absorb water (and release water when timber dries).

ii. The per hectare richness and density of commercial species in most of the Amazonian tropical forests is inferior to that of the more bountiful tropical forests of East Asia and much of West Africa. Nevertheless, deforestation of Brazil's tropical forests has been occurring at very high rates over the past three decades, as noted below. As we shall note, harvest of tropical wood for export was one of the causes, but not the primary cause.

The marked shift in composition of tropical hardwood exports came in response to policies in exporting nations – especially in East Asia – intended to secure higher "domestic value-added" in timber exports. The expectation in every case was that higher domestic economic returns (wages, capital income) for exporting nations could be secured by adopting policies strongly geared to promotion of domestic processing of logs into sawn timber and plywood. These expectations for higher "domestic value added" have been often proved disappointing, especially in Indonesia, where subsidized plymills were far less efficient (more wasteful) than plymills in Japan and the U.S. [footnote]In any case, expanding investment in plymills and sawmills, especially in East Asia, was responsible for a significant shift away from log exports and toward plywood and sawnwoods made from tropical hardwood. In 1980, logs constituted 75% of all tropical hardwood exports, sawnwood 16% ad plywood only 9%, out of the nearly 40 million m^3 of exports. By 1987, logs were but 45% of the total, while the shares of sawnwood and plywood rose to 28% each. The shift away from log exports continued into the 21st century, so that by 2007, 85% of Asian exports were of processed tropical hardwood (FAO, 2009).
Repetto, Robert and Gillis, Malcolm (1988). Public Policies and The Misuse of Forest Resources. NY: Cambridge University Press.

II. RESOURCE BASE

As late as 1980, the worldwide tropical forest estate (total closed forest area) was 1.26 billion hectares, largely concentrated in Brazil, East Asia and West and Central Africa. More than a billion people rely on this forest for a living, both directly and indirectly. The tropical forest endowments that have furnished wood exports from East Asia and Africa were once regarded as an inexhaustible resource. However, they have been severely depleted over the past six decades, especially since 1970. Logging for both export and local use has been a major, but far from the only, cause of widespread tropical deforestation in the second half of the twentieth century and the first decade of the 21st century. Rural poverty itself has been a major cause of deforestation in the tropics. Harvest of tropical timber by poor rural dwellers in an ever-more desperate search for firewood has been a significant cause. In some tropical nations, firewood gathering has been the prime cause of deforestation. In Ghana, in the eighties, for every tree harvested for export, eight were cut down for firewood. In Indonesia in 1979, fuelwood consumption was nearly four times the volume of wood commercially harvested that year. In more recent years, forest clearing for palm oil plantations, to meet European demand for biofuels, has become a major source of deforestation in Indonesia (1990-2008). Other important causes of deforestation vary according to the country. Swidden agriculture (shifting cultivation) was a major source of deforestation in Indonesia and East Malaysia (Sabah and Sarawak) until about 1980, and remains an important factor in parts of Africa today. Clearing of large tracts of forests for cattle ranches in Brazil has been the most significant cause of deforestation in that nation. According to one estimate, land clearing for cattle ranches accounted for fully 80% of Brazilian deforestation.[footnote] {For a worldwide perspective on deforestation see Repetto and Gillis (1988)}. [footnote]
Nepstead, et al. “The End of Deforestation in the Brazilian Amazon”, Science, Vol. 326, December 4, 2009.
Repetto, Robert and Gillis, Malcolm (1988). Public Policies and The Misuse of Forest Resources. NY: Cambridge University Press.

Deforestation in the tropics has truly sizable implications for climate change. Forests lock up massive quantities of carbon. Deforestation in Brazil and Indonesia proceeded at rates high enough so that by 2005, these nations were the third and fourth ranking sources of CO_2 emissions, after China and the United States.

Table 13-3 portrays, for the period 1990-2000, patterns of tropical deforestation among the major exporters of tropical hardwoods. It also presents a comparison with the worldwide average for deforestation, with benchmarks for all lower income nations, the U.S and Europe. It is readily apparent that while deforestation has had many causes, deforestation in nations exporting tropical hardwood, whether as logs, sawn timber or plywood, has proceeded at rates several times that of the world as a whole. Deforestation has been especially severe in some tropical nations. By 2010, deforestation in Ivory Coast, Ghana and Thailand had reduced the forest estate to a minuscule proportion of its original extent.

	Forest Area (a) in 2000	**Average Annual Deforested areas (a)**	**Deforestation annual rate %**
Brazil	5,325	22.2	0.4
Cameroon	239	2.2	0.9
Indonesia	1,050	13.1	1.2
Malaysia	193	2.4	1.2
Papua New Guinea	306	1.1	0.4
Philippines	58	0.9	1.4
Thailand	148	1.1	0.7
World-wide	38,480	95.0	0.2
Low-Income	9,031	73.0	0.8
U.S.	2,260	-3.0	-0.2
Europe	846	-2.9	-0.3
(a) in thousands of sq. km Source: World Bank, World Development Indicators, 2004 (Washington, World Bank, 2005, Table 3.4)			

Table 13-3 Average Annual Rates of Tropical Deforestation Major Hardwood Exporters, plus U.S. and Europe 1990-2000

Deforestation in the eighties was, if anything, even more severe than during the nineties. Table 13-4 presents deforestation rates for major exporting nations, plus countries such as Honduras and Cote d’Ivoire, which had largely been deforested by 1995. Brazil finally took steps, in recent years, to curb deforestation by expanding the network of protected areas. In 2008, the Brazilian government announced a new set of programs to reduce deforestation rates to 20% of the historical trend by the year 2020. The program will cost between $7 and $18 billion over the next 10 years.[footnote] Nepstead, et al. “The End of Deforestation in the Brazilian Amazon”, Science, Vol. 326, December 4, 2009.

	Annual Average Rate of Deforestation

Brazil	0.4
Cameroon	0.4
Cote d’Ivoire	5.9
Honduras	2.4
Indonesia	0.5
Malaysia	1.2
Papua New Guinea	0.1
Philippines	0.7
Thailand	2.4
Source: Robert Repetto and Malcolm Gillis, eds, Public Policy and the Misuse of Forest Resources, (N.Y., Cambridge University Press, 1988).	

Table 13-4 Deforestation 1981-85 Selected Exporters of Tropical Hardwoods

As Denslow has noted, massive forest destruction in the tropics over the past six decades had an important historical antecedent: the opening of the great eastern deciduous forests of North America in the eighteenth and nineteenth centuries.[footnote] This was accompanied also by high rates of deforestation until the early 20th century. These temperate zone forests had largely recovered by the 21st century: the U.S. east of the Mississippi had more forest cover in 2000 than in 1900.
But the nature of the soils in tropical forests is such that the prospects for reforestation there are much more limited than in the temperate forests of North America.[footnote] This is largely because the nutrient-holding capacity of the soils of the moist tropics is very low. The above-ground biomass contains over 80% of the nutrients in a tropical forest versus less than 25% in temperate forests. In temperate forests, the forest floor consists primarily of the forest itself: needles, leaves, ground litter from dead trees, mosses, etc. This forms a natural compost for temperate forests; the above-ground biomass contains less than 30% of nutrients in the forest. But when tropical trees are harvested, a very large share of the ecosystem nutrients is permanently removed (even when selective cutting, rather than the less frequently used clear-cutting method is employed for harvest). Significant reforestation in the tropics, should it ever occur, will therefore be very expensive, especially with regard to fertilizer needs, and will require many decades. It is therefore quite clear that tropical forest resources cannot be viewed as inexhaustible, as was the prevailing view until quite recently.

Denslow, Julie S. (1988). The Tropical Rain Forest Setting. Washington, DC: The Smithsonian Institution.

See Chapter 9 Ashton, Peter and Panayotou, Theodore (1992), Not by Timber Alone, Washington, D.C.: Island Press and Whitmore, T.C. (1984), Tropical Rain Forests of The Far East, Oxford Clarendon.

III. MARKET TRENDS

We have noted that a very large share of tropical hardwood exports has originated in the rich dipterocarp forests of East Asia, primarily Malaysia, Indonesia and Philippines. Species especially favored in export markets after 1970 were members of the genus Shorea, known as *meranti* in Indonesia and *lauan* in the Philippines. Other valuable species included *ramin* (Indonesia and Malaysia). Valuable West African species included *acajou* (mahogany), *iroku*, *sipo* and *afformosia*.

The great size, richness and accessibility of the forest estate in East Asia, relative to Africa and Brazil, has had important implications for international trade in tropical hardwoods. This is most evident in the experiences of Malaysia and Indonesia. In the first two decades after WWII, most Malaysian exports arose from West Malaysia (Peninsular Malaysia). After 1980, exports from the East Malaysian states of Sabah and Sarawak began to outpace those of West Malaysia. Indonesian exports of tropical hardwoods were negligible until the late sixties, but began to grow rapidly after 1971.

In 1971, the total value of hardwood logs, sawnwood and plywood exports from Malaysia was $611 million, mostly in the form of logs. By 1984, Malaysian hardwood exports reached $2.9 billion – a nearly 5- fold increase over 13 years. Indonesian exports in 1971 were but $170 million; by 1984 they had reached $1.2 billion, a seven-fold increase. Exports from the Philippines and Thailand were significant in the early post war period, but dwindling forest resources in both nations have sharply reduced their shares in the market.

Philippine hardwood log exports were negligible until the end of World War II. Then, large-scale mechanized logging by U.S. based firms began to transform the industry. The peak years of logging exploitation came during the early seventies, but the rapid shrinkage of productive forest area led to slow growth in hardwood exporters thereafter. By 1984, total Philippine hardwood production was but 1/3 that of 1974.

Over the past two decades, tropical hardwood export values grew strongly both for Indonesia and Malaysia. By 2007, Malaysia’s exports reached nearly $5.5 billion, while those of Indonesia climbed to $3.9 billion. In both countries, plywood and wood panels constituted over 80% of export value.

The price structure of tropical hardwood exports has exhibited interesting patterns over the past four decades. This is evident in [link]. (It is to be noted that the figures in Table 13-5 refer to real (inflation – adjusted) prices, expressed in prices of the year 2000.)

	1970	**1980**	**1990**	**1995**	**2000**	**2005**	**2008**	**Percent Change Over Entire Period**

	1970	1980	1990	1995	2000	2005	2008	Percent Change Over Entire Period
I. Logs ($ per cubic meter)								
A. Cameroon	149	310	334	282	275	304	415	178%
B. Malaysia	149	241	172	212	190	184	230	54%
II. Plywood (dollars $/sheet)	3.57	3.38	3.45	4.85	4.48	4.62	5.11	43%
III. Sawnwood (Malaysian $ per m^3)	608	489	518	614	595	599	701	15%

Commodity Prices –Tropical Logs and Plywood, in USD 1970-2008 (In prices of year 2000)Source: World Bank, World Development Indicators, 2009 (Washington, DC: World Bank)

Over the period 1970-2008, real export values per m^3 for logs from Cameroon rose by 178%, indicating notable gains for exporters of tropical hardwoods: the purchasing power for each unit of exports rose over the entire period, even though real prices for the ten years between 1995 and 2005 dipped somewhat.

Price trends for plywood and sawnwood on the other hand, rose steadily over the entire three decades after 1980, but did not experience the sharp gains recorded for Cameroon logs.[footnote] Between 1970 and 2008, the real price of plywood per sheet rose from $3.57 to $5.11, an increase of 43%, while that for sawnwood rose moderately by only 17%.
The much sharper increases in log prices relative to plywood and sawnood are largely attributable to steady shrinkage in availability of logs, owing to policies in exporting nations that have strongly discouraged export in log form, and strongly favored processed wood exports.

As Table 13-6 shows, the long-term pattern of “real” (inflation adjusted) export prices for hardwoods generally have not been untypical of other primary export commodities. A few of these enjoyed steady but not spectacular gains in purchasing power per unit of export over the entire period 1970-2008. However, four commodities experienced very large real price increases over the 38 year period: There were phosphate rock, copper, gold and nickel.

Commodity	Inflation Adjusted Prices		Percent change over entire period.
	1970	2008	
Rubber (a)	176	206	+17%
Phosphate Rock (b)	58	272	+368%
Aluminum (b)	1,795	2,027	+13%
Copper (b)	2,690	5,481	+104%
Gold (c)	125	687	+450%
Nickel (b)	8,037	16,635	+106%
Tin (d)	1,273	1,459	+15%
Source, World Bank, World Development Indicators, 2009(Washington, DC: World Bank, 2009)			

Table 13-6 Selected Real Commodity Prices 1970-2008 (In prices of year 2000)

However, one should be careful to note that if 1980, rather than 1970 were used as a base year, the price of gold actually fell in real terms.[footnote] Copper had gains comparable to tropical logs, while tin and aluminum gains were much lower. We may conclude that primary commodities have consistently been fairly good hedges against inflation, except perhaps over in the very short term (one to two years). Gold was a good hedge over the whole period, but a poor one for the period after 1980. The nominal (unadjusted for inflation price of Gold reached $980 per troy ounce in 1980. In mid 2008, the nominal price was only $900. Since inflation over the period 1980-2008 averaged about 2% per year the real price of gold fell significantly during the period, in spite of price spikes after 2007.

IV. CONCLUSION

For tropical hardwoods, the export boom that began after World War II had mixed results for exporting nations. To be sure, very substantial amounts of tropical wood and wood products were exported, primarily to the U.S., Europe, and after 1982, to China. In the process, very large swaths of previously undisturbed tropical forests were deforested. In contrast to North America, these tracts will never be easily reforested. There was some employment growth in the export sector for hardwoods in tropical nations, but by their very natures, modern log harvesting and processing methods are capital-intensive, not labor intensive. Governments did capture significant tax revenues from exports of tropical hardwoods until the 1980's, when heavily taxed log exports gave way to very lightly taxed or untaxed sawnwood and plywood exports.[footnote] Finally, the business of exporting tropical hardwoods – in log and processed form – was one in which the purchasing power of the exported commodities increased significantly over the period under review, especially logs.

Repetto, Robert and Gillis, Malcolm (1986). Public Policies and The Misuse of Forest Resources. NY: Cambridge University Press.

Future economic historians will face the task of determining whether the extraction and processing of tropical timber has brought net benefits or net costs to exporting nations, after considering all economic gains (in export earnings, taxes, etc.) against all economic costs (ecological damages, decline in value of non-wood products and services offered by intact tropical forests). The benefits to nations importing tropical hardwood products have been apparent. Growing reliance on tropical hardwood products in building and housing construction has allowed not only cost savings through cheaper construction, but also less pressure on forests in the importing nations.

RELATED ISSUES IN SUSTAINABLE DEVELOPMENT AND THE ENVIRONMENT

Other Dimensions of Sustainable Development

This module examines some acute environmental dilemmas facing poor countries in the 21st century. A later module discusses the most significant chronic environmental problem facing emerging nations: climate change.

Examples of acute conditions:

- Groundwater pollution from cadmium, mercury and other heavy metals (i.e. don't eat fish caught in Tanjung Priok, Indonesia – Jakarta's port.)
- Air pollution, especially in Northern China
- Growing scarcity of freshwater supplies worldwide especially in China and India

Groundwater pollution has threatened the health of such densely populated urban areas as Jakarta, Sao Paulo, Mexico City and Silesia in Poland for decades. Rural dwellers face groundwater contamination from runoff of pesticides and fertilizers in at least a dozen developing countries, where heavily subsidized prices of these inputs have led to overuse. River and watershed pollution in 1990s made such rivers as the Vistula in Poland unfit even for industrial use for a time. We have already noted the effects of nitrate pollution on drinking water in Czechoslovakia in the 1990s, such that women with newborn infants were given priority to access to bottled water for their infants. In at least one Caribbean island, three and four year-old girls have presented with a syndrome involving precocious development of adult sexual organs: unknown toxins that have found their way into the drinking water are prime suspects.

The air is at times as unbreathable in Mexico City as in Northern China due to air pollution. Erosion has led to such heavy siltation of man-made lakes for hydropower projects that the useful lives of many dams/hydro installations have been slashed from 75 to 10 years, in China, the Philippines, and Indonesia. In the Philippines and several other nations, coral reefs and valuable coastal fishing areas are being destroyed by sediments coming from far-away upland forests converted to shifting cultivation. And the cause of coastal degradation is not limited to deforestation. In several South American nations, mercury was long used to concentrate gold from gold ore. Methyl mercury pollution from decades ago has reached bays and coves in Brazil and Andean nations, resulting in human exposures hundreds of times above dangerous levels with widespread neurotoxic effects. The short term effects of such pollution on native populations are well recognized. But even worse, methyl mercury lingers in bays for hundreds of years. Virtually nothing is known about the more insidious long-term effects on human health.

We noted earlier that severe sustainability problems are now appearing in clumps or clusters, especially in urban and industrial areas in the tropics. As a result, officials and environmental groups from Mexico City to Jakarta and Bangkok confront the grim possibility of environmental triage: with limited financial resources and expertise, not all or even most urgent environmental dilemmas can be confronted. How does one choose which perils are to be dealt with first? How will decision-makers be guided in selecting how many divisions to shift to which environmental battlefield? What criteria will they use in these decisions? Should they invest in measures to reduce threats to human health for current generations, or should resources be concentrated upon reducing the risks facing the next generation? Can the nutritional and health effects of loss of employment for thousands of workers in polluting industries be ignored if these industries are shut down? Should saving the livelihoods of fishermen be given a heavier weight than the livelihoods of pulp and paper workers in decisions to close polluting coastal paper plants?

These and milder forms of environmental triage involve economic, ecological, and ethical questions of the most fundamental nature. Even if information about the severity of these problems were much more available, and even if we were more confident of what remedies could be applied, there is still little systematic basis for intelligent and humane choices in coping with such a wide array of environmental dilemmas.

But, a start has to be made somewhere. As a beginning, serious efforts are required to mend the long broken circle between economics, ecology, and ethics.

Economics, Ecology and Ethics

Much of the international debate over global environmental problems has been conducted as if economic values, and economic interests, are inherently in conflict with ecological and ethical values. But to a degree not widely appreciated at present, economic, ecological, and ethical rationales for sustainable and environmentally sound development are interconnected, and often mutually reinforcing. A main reason for the lack of widespread recognition of the linkages between these rationales has been the obscuration, in this century, of the linkages between the disciplines from whence they came. The compartmentalization across and even within disciplines, such as economics and the resulting focus on studying parts in isolation from the whole, has been responsible for much of the problem.

Thus, the linkages between economics, ecology, and ethics have been largely severed by decades of growing disciplinary reductionism. Can these links be restored sufficiently to allow societies to begin to devise new tools to cope with sever environmental degradation?

It is very doubtful that many modern economists are aware that their discipline has its roots in what was called moral philosophy not a century ago. Some economists who do know this might even be reluctant to admit it. But, the fact remains, the venerable Adam Smith himself was famed as a moral philosopher long before he published the Wealth of Nations in 1776. And the economist who first caused economics to be called the dismal science was the Reverend Thomas Robert Malthus. In the United States, the first courses labeled as “economics” were often taught by clergy. Before 1890, economics was almost invariably considered an adjunct to moral philosophy. The American Economic Association, established in 1885, counted among its founders and early adherents a “sizeable contingent of clergymen.” At Cambridge University in England, economics was, until very recently, taught as part of the moral science tripos. Moreover, consider Alfred Marshall, the mentor of Keynes and one of the founders of the school of neoclassical economists, and the 900 pound gorilla of British economist from 1890 until his death in 1924. Marshall habitually referred to political economy's "sister, the science of ethics." Further, the modern discipline of economics grew up hand in hand with the utilitarian philosophy of Bentham, Mill, and others.

In any case, the moral and ethical content of economics instruction was once much more explicit than now. It has not been absent in the mainstream economics of the past quarter-century. Rather, it has been largely unacknowledged. Why? 21st century economists contend that the prevailing paradigm in their field is, or could be made to be, value-free. Not all agree. No less a contemporary economic figure than future Nobel Laureate A.K. Sen has argued that the discipline has been substantially impoverished by the distance that has grown between economics and ethics.

It is helpful to understand that Western-style economics is, in fact, fundamentally based on the value judgment that individual preferences should count in the allocation of society's scarce resources. Many economists recognize that this moral judgment lies at the heart of their discipline. Many such as the author are quite comfortable in having it there. But to ignore the ethical foundations of economists' normative prescriptions is to increase the serious risk that only economic rhetoric will be used in debates over questions when much more than economics is needed to resolve them.

Certainly, economics as a disciple cannot by itself be expected to provide answers to ethical dilemmas. A central ethical issue in controversies over natural resources use and the environment the issue of intergenerational equity: to what extent should current decisions affecting exhaustible resources and the environment reflect the interests of generations to follow? An answer to these questions cannot be provided merely by economics, but only by some ethical system. And even given an ethical system, the question is not easily resolved. The implications of some ethical systems may surprise the reader. For example, an egalitarian set of ethical criteria such as those proposed by now deceased Harvard philosopher John Rawls, may indicate that the current generation should consume either more or less resources than the next, depending both upon future rates of technical progress, population change and the current size of the stock of exhaustible resources.

Whatever the ethical criteria used, an economist can no more specify an optimal rate of say, deforestation across generations than they can specify an optimal rate of national savings. Economic analysis, however, is in fact very useful in sensibly framing the questions to be asked in problems involving the interests of several generations.

The ethical foundations as well as the limitations of economic analysis are in any case not at all difficult to demonstrate. But what of the nexus between the older word, “economics” and “ecology”? Ecology is a modern word that first appeared in the 1870s. The Oxford Dictionary defines ecology as the science of the economy of animals and plants. The etymology of the two words also suggests that the two were once more tightly bound than at present. The first two syllables of each are formed on the Greek oiko(s), meaning “house” or alternatively, “place.” But the connection between economics and ecology surely extends beyond etymology: good economics is not only good ecology, but indeed is required for good ecology. The dichotomy that many perceive to have arisen between economics and ecology is false and has persisted primarily because of narrowly focused on not-so good economics.

Consider the economist’s approach to problems in the distribution of income between rich and poor, a matter that can be settled only by resort to ethical as well as economic norms. The economist’s approach does turn out to be helpful in dealing with questions at the intersection of ecology and economics. Not only have ecological catastrophes been almost always economic disasters (and though the reverse is generally true), ecological calamities have had catastrophic implications for income distribution. And, the reverse is often true: maldistribution of income has often been a prime cause of ecological calamities. This happens when the landless poor have no options but to cut down the rain forest for fuelwood or shifting cultivation activities to survive.

Consider the Aral Sea. The massive wastage of this resource resulting from this exercise in Soviet Central Planning. The waters of the Aral Sea were used to irrigate cotton crops in arid areas. This use has sharply reduced the area of this freshwater body, once larger than West Virginia, over the past five decades. The water was provided to cotton farms at near zero costs. The economic costs of the resultant steep loss of biological productivity of the sea has included the disappearance both of the commercial fish catch as well as 60,000 jobs in the area. Environmental consequences have included powerful dust storms arising from overdried areas of land surface, as well as distinct alterations in temperature and moisture conditions over a wide area adjacent to the area. For the future, the sea could dry to a residual brine lake. Sadly, virtually none of the dozen or so schemes discussed in publications by western and Soviet scientist to preserve the Aral Sea make any mention of the role that higher prices for irrigation water might play in water conservation.

In the case of both publicly-owned rangelands in the U.S. and the Aral Sea, higher prices for grazing fees and water, respectively, could have forestalled much of the environmental damage that has already occurred.

These examples suggest that before we mount a search for a different kind of economics to deal with ecological questions in their ethical setting, it behooves us to consider whether we are properly using the economics we already have. In turn, this requires efforts to mend the broken circle between economics, ecology and ethics. The first step calls for substitutions of good economics for the not-so-good economics that have formed the basis for much of the policies that have encouraged environmental degradation.

We illustrate by turning once again to the problem of tropical deforestation.

Green Backfires

Things are not always what they seem to be in economics.[footnote]
See Robert Repetto and Malcolm Gillis, Public Policies and the Misuse of Forest Resources, Cambridge University Press, 1988.

We have reviewed policies toward forestry endownment that have had unintended destructive effects. If one examines carefully at government policies worldwide, one would be shocked at how many others have large unintended effects. And the unintended effects are almost never positive. But even worse there are numerous examples of policies affecting the environment that not only have unintended effects, but absolutely perverse effects.

That is, the policies intended to achieve a good end actually make the problem worse. In this volume, we label such policies as “Green Backfires”. These are policies that purport to protect the environment by either reducing CO^2 emissions or by attaining some other environmental goal.

The first two Green Backfires are subsidies intended to curb CO^2 emissions to reduce global warming or to protect forests. These are indirect subsidies, because they do not involve direct government spending. Rather the subsidies result from other incentives contained in the policies.

Of course we already know that the U.S. ethanol subsidy is a horrible example of Green backfire. The three we cover today are:

1. The EU policy of requiring that the first 10%, and in 2020, 20% of transport fuels be “renewable”
2. The EU decision that classifies wood as a renewable source of fuel
3. EU rules and regulations on GM food which are far more restrictive than such rules in the U.S.

Green Backfires, Biofuels and BioFools

The first green backfire was also a sixth reason for rapid tropical deforestation, in addition to the five others discussed earlier. The origins of this backfire: European Union policymakers believed that using palm oil as a feedstock for biofuels would results in carbon savings of 56% over fossil fuels. But they did not take into account the deforestation driven by increased palm oil production. As a result, huge swaths of Indonesian tropical forests were cleared to meet rapidly growing European needs for palm oil.

Palm oil trees grow only in the tropics. In tropical nations, one obtains palm oil first by forest clearing, then planting palm oil trees. Malaysia was long the largest palm oil producer, harvesting the product from plantations that are now over 40-50 years old. But Indonesia palm oil output has grown very rapidly since 1985. Together Malaysia and Indonesia produce 80% of the world's palm oil.

Palm oil production exploded in Indonesia after 1985 because of the world's headlong and often ill-advised rush to biofuels, in the belief that biofuels are always renewable or "green", that use of biofuels to replace fossil fuels will reduce CO^2 emissions.

Palm oil has been increasingly used as a feedstock for biofuels in Europe. In 2003 the EU enacted a stiff requirement to promote palm oil as a biofuel to reduce usage of gasoline and diesel fuel. Huge areas in the Indonesian tropical forest were cleared to enable planning of palm oil trees. As a result, palm oil exports from Indonesia grew very rapidly from 2003-2007. Then in 2007, the EU raised the biofuel target to 10% of transport fuels for the year 2020, further boosting the demand for palm oil, and boosting the Indonesian export price of palm oil. AS a result, Indonesia's palm oil exports grew from only $200 million in 1990 to nearly $8 billion in 2007: a 40 fold increase!!

In the process the Indonesian natural forest was being sacrificed so that Europe could reduce its dependence on hydrocarbons: deforestation caused by biofools promoting biofuels. But: on balance CO^2 emissions have as a result likely increased, not decreased, contrary to the intended outcome.

Even GreenPeace, an outfit not primarily known for hard-headed economic analysis, has condemned the conversion of forests to palm oil production to satisfy Europe's fuel needs.

Their quest for "clean" fuel led to a cleaning out of the tropical forest. But there is more. This kind of forest conversion now has become a very serious threat to the existence of many forest animals, especially orangutans. The name means in Indonesian "man of the forest".

There are only about 50-60 thousand orangutans left in the world. They require large tracts of jungle to survive. They cannot survive in the monocultures that are palm oil plantations.

In deforestation, are things changing for the better? Somewhat, in some venues. For example, after decades of heavy, misdirected subsidies for land-clearing for cattle raising and plantation agriculture Brazil finally began curtailing their grossly wasteful and destructive incentives in the late nineties. And as noted, Brazil in 2009 finally began clarifying property rights to forest, to make them secure.

Indonesia has also undertaken some measures to protect what is left of her intact forests. Subsidies to plywood mills are less important than they used to be. And, years ago, the government established a 1,600 square mile forest reserve in Southern Kalimantan. There live 6,000 endangered orangutans, the second largest concentration of these primates anywhere. The park is called Tanjung Puting national Park. That is good news. The bad news- Indonesia seems unable to resist intrusions in the park by tree poachers.

Just in the month of July 2008, loggers cut over a 40,000 acre area in the NE side of the park, to clear the forest for new palm oil plantings. This illegal logging alone displaced 560 orangutans.

The European palm oil initiative for so-called “green fuels” is just on more example of how policy failures in rich and poor nations wreak environmental havoc in poor nations.

Second Green BackFire[footnote]
See “The Wisdom of Governments”, The Economist, April 6, 2013.

One truly perverse green backfire coming from Europe: classification of wood as a renewable resource to be used in electric power generation.

But what in fact is one of the main beneficiaries of the EU policies toward non-renewables?

Specifically, when the EU decided to label wood pellets as a renewable, its usage in electric power generation skyrocketed. The wood pellets are utilized in "co-firing" power stations that burn 90% coal and 10% wood. This is supposed to cut down on carbon emissions.

The EU goal is to have "renewables" constitute 20% of its energy by 2020. This goal cannot be reached without "co-firing." Indeed, a few power stations in England and Germany have been converted to run on wood energy alone.

This source of energy is actually subsidized (about U/S/ $63 per megawatt hr).

In 2012 Europe consumed 13 million tons wood pellets much of which came from forests in the U.S. What is wrong with this picture? Wood as a fuel yields carbon twice over:

1. When you grind it up
2. When you ship it

In fact, to produce 1mwh of electricity from wood pellets releases 200 kg of CO^{2} into the atmosphere. Is this good environmental policy?

According to research by Tim Searchinger of Princeton University, using whole trees to produce energy increases carbon emission by 79% compared with coal over a 20 year period.

This green backfire increases carbon emissions, rather than decreasing it.

Genetically Modified Food

A third serious example of "Green Backfire" with adverse environmental and nutritional impact on poor countries has been the widespread phobia toward genetically modified foods such as "golden rice". Golden rice was genetically engineered to produce betacarotene, to help reduce Vitamin A deficiency, which causes 2 million deaths a year in young children. This phobia is deeply seated in some continental European countries (e.g. France and Germany) and has been exported to many African nations. In the

former group of rich countries, laws and regulations severely restrict both the use of genetically modified seeds as well as genetically modified food products, including basic grains. Fear of genetically modified foods persist in Europe in spite of the fact that billions of people have eaten such foods since 1990. Not one problem has been found. Indeed one respected scientist claims that there is not a single credible report of dangerous health effects from genetically modified foods.[footnote]
Pamela Ronald, “How Scare Tactics on GMO Foods Hurt Everybody”, MIT Technology Review, June 12, 2014.

Opponents claim that GM foods cause cancer. That was the claim made in a now discredited article in 2012 in publication Food and Chemical Toxicology. The article was retracted on November 28, 2013, and the claim labeled as false. No other study has found health risks in mammals from eating GM food. The overwhelming scientific consensus is that transgenic crops are as safe as unmodified ones.[footnote]
Mark Lynas “Some GMO Crops Are on the Same Side as Their Opponents”, MIT Technology Review, December 17, 2013.

Still, throughout Europe, genetically modified foods are called “frankenfoods,” after the famous monster in Mary Shelley’s Frankenstein novel of the 19th century several U.S. states have restricted GMO foods. In Africa, owing to European examples many poor nations have refused to allow planting of genetically modified seeds and have even refused to allow import of shiploads of genetically modified grains, even when the grain is offered as foreign aid to the importing country. For example, Zambia, where starvation was widespread in 2002, refused donations of genetically modified corn in that year. People starved as a result.

There are actually two types of genetically modified foods. First, humans have been breeding crops since agricultural societies replaced hunter gatherers societies over 3,000 years ago. Breeding of corn, rice and other products, then and now, genetically alters them. So humans have been consuming one form of genetically modified food for several millennia, without arousing phobias.

The second type of genetically modified food dates back only a few decades, to the dawn of biotechnology[footnote] . Seeds are developed in

laboratories to create crops that have such desired characteristics as resistance to drought, disease, insects, pesticides and herbicides, or to otherwise increase the productivity of harvests, as for example requiring less water for cultivation.
For a cogent discussion of the benefits of genetically modified crops, see Nobel Laureate Marc Van Montagu,: The irrational fear of genetically modified food," WSJ October 24, 2013.

It is this second type of genetically modified food that has attracted such foods as unhealthy. But there is an absence of documented scientific evidence showing that genetically modified food causes cancer or any other diseases. In addition, there is a decades-long safety record in applying biotechnology to improve food crops. The fear of genetically modified food can thus be labeled only as irrational and poorly founded, especially given that almost two-thirds of processed food products already on sale in grocery stores contain genetically modified ingredients.

This irrational fear has consequences both for nutrition as well as environmental degradation, especially in poor tropical nations. Restrictions and prohibitions on planting genetically modified food have, by restricting supply, raised the cost of commercialization of the genetically modified foods. Higher prices for food grains – especially prevalent in the years 2007-2011 – reduce accessibility of food to the poor, especially the poor in the poor nations.

In addition, restrictions on planting or consumption of genetically modified foods in Africa and elsewhere among emerging nations yield ecological damages. When genetically modified seeds displace traditional ones in say, Africa, several positive environmental consequences can emerge. Where fresh water is scarce, genetically modified crops can reduce the water intensity of crops. Genetically modified crops can help conserve precious soil endowments allowing no-tillage farming (planting crops without the need for deep furrows that cause topsoil loss). Genetically modified crops can materially reduce the need for insecticides and risks of contamination of groundwater and topsoils.

Where genetically modified foods have not been fully blocked, as in India, the consequences for economic development have been quite positive.

There, insect resistant, genetically modified cotton has allowed India, once an importer of cotton, to become an exporter. Elsewhere in India, insect resistant GM crops have reduced contaminants from insecticide spraying by more than 25%, and as much as 60% in other regions. Even in the face of evidence of the benefits of genetically modified crops to poor countries, opponents continue to incite irrational fears through bogus reports on their effects, such as the discredited study that claimed consumption of genetically modified crops cause cancer. Another example was the widespread rumor, propagated on the internet, that genetically modified cotton caused suicides among Indian farmers. This myth was totally discredited by a study in 2008 mounted by a consortium of 64 governmental organizations and NGOs.

It is clear that the irrational fears of genetically modified foods, which first arose in Europe and then spread to several African countries, has had serious negative implications both for nutrition and for the environment in poor nations.

NATURAL CAPITAL: ENERGY

This module covers significant aspects of energy utilization, energy technologies, and production. We defer the discussion of the role of energy use in global climate change to a later module.

Hydrocarbon Energy: Oil and Gas, Coal

Attitudes towards energy endowments vary considerably. By the 21st century, some–including several in academia–began to view large endowments of energy resources as a "curse." Indeed, one label long applied to overdependence on oil and gas is "Dutch Disease"[footnote]: the effects of oil exports on reducing total employment and increasing inflation in exporting nations. Dutch disease has indeed adversely affected Nigeria, Venezuela and several other nations.

The term first appeared in the 1970s, when Holland began to exploit very large reserves of natural gas in the North Sea. For several years after exports began, unemployment rose in Holland.

Elsewhere, people and their leaders hope for discoveries of energy resources that might bring future prosperity. Fortunately, the so-called energy curse is not at all inevitable. Energy itself is not the culprit. Any "curse" arises from (a) the unwise utilization of revenues from energy resources, especially when accompanied by the corruption and/or economic repression associated with such major oil exporters such as Nigeria or Venezuela; (b) bad economic management: perverse government policies that cause inflows of oil revenues to adversely affect foreign exchange rates and therefore non-oil exports, especially labor-intense exports; and (c) finally, the absence of policies that require large chunks of natural resource revenues to be put aside for the benefit of future generations. The set asides of natural resource earnings are already used in Norway, Alaska and Chile (copper).[footnote]

By mid-2014, Norway with a population of only 5 million had accumulated funds exceeding $850 billion in oil-fed trust funds, available to future generations of Norwegians.

In any case, attitudes toward energy endowments have differed greatly, both across and within countries.

Consider a 1973 statement by Golda Meir, the 4th Prime Minister of Israel."“Let me tell you something that we Israelis have against Moses. He took us 40 years through the desert in order to bring us to the one spot in the Middle East that has no oil.”"

On the other hand, Saudi Arabia has truly immense reserves of oil and gas. But, consider an entirely different point of view, set forth by Sheik Yamani, the Saudi Arabian Minister for Energy in the early eighties.""I wish we had struck water.""

Actually, Mrs. Meir spoke too soon. Huge deepwater gas deposits were discovered in 2010 in the Mediterranean Sea in Israel’s waters. Two fields hold about 28 trillion cubic feet of gas. The gas began flowing on March 31, 2013. The Prime Minister, Benjamin Netanyahu, called it “Manna from heaven” in 2014.

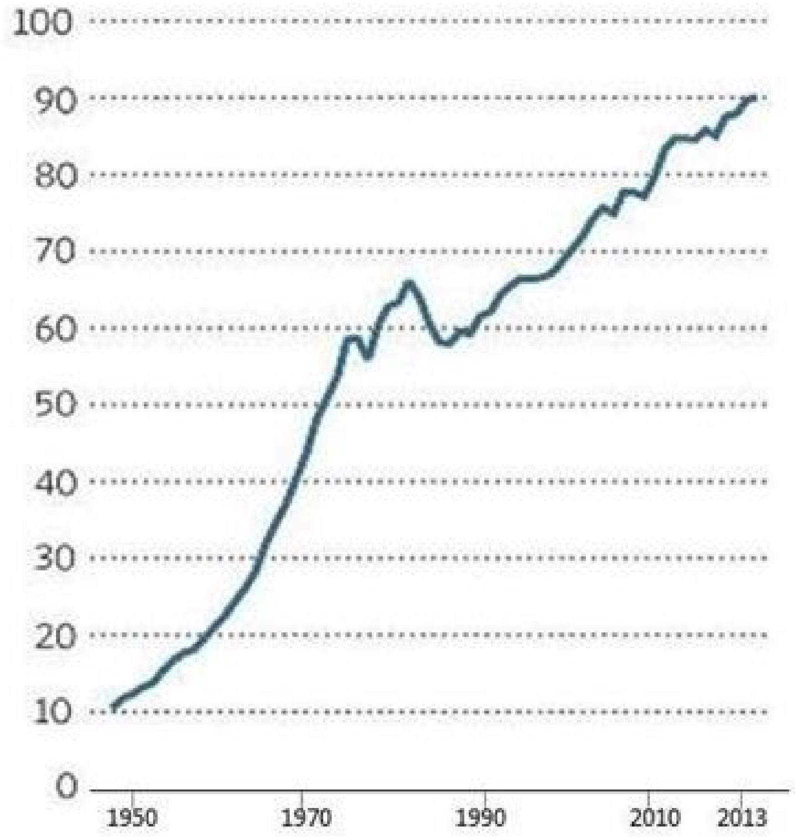
The Evolving Outlook for World Energy

The world energy picture and outlook in 2014 is vastly different from that prevailing a half century earlier. In the 1960s, 1970s, and even later, there was a widespread consensus even among oil and gas specialists that the world’s oil production would peak, probably by the 1970s, and then begin to steadily decline thereafter.[footnote] This conviction attracted even more adherents when world oil output did peak temporarily in the mid-1970s. The first of the well known prediction of “peak oil”, was a Shell Petroleum geologist M. King Hubbert. Even as late as 2005 industry leaders such as T. Boone Pickens asserted that global oil production would peak at 84 million bbl/d. By 2013, production reached 90 million bbl/d, and was still rising in 2014.

But, as shown in Figure 15-1 below, world oil production began rising again thereafter, from 65 million bbls/d to 90 million in 2013. Pessimistic forecasts for energy production did not materialize for two main reasons. First, the forecasts did not take into account the potential effects of higher oil prices or incentives to explore and develop new deposits. But world oil prices did rise sharply, from less than $3 a barrel in 1973 to over $100 in 2013. Second, the forecasts ignored advances in technology in oil and gas exploration, and development. Chief among these innovations were: (a) advances in seismic imaging, which vastly improved the ability of oil companies to locate deposits, especially very deep ones, (b) horizontal drilling, which made possible the introduction of "steerable" drilling systems in 1984, thereby increasing recovery of oil from any given deposit, and (c) the combining of hydraulic fracturing (first introduced in the 1960s) with directional drilling. These technological innovations are discussed in detail in subsequent sections of this module.

As a result of technological innovation in the 20th century the first two decades of the 21st century have featured very significant changes in resource availability and technology in the industry; most of these changes were unforeseen.

The most important unforeseen change has been the emergence of abundant natural gas, and to an extent, oil from deep shale formations, especially in the U.S. Other nations, including Colombia, Argentina, China and Russia also have ample but yet unexploited shale deposits, as we shall see. Note that the presence of abundant endowments of oil and gas in shale is no guarantee that they will all be exploited. Chinese shale reserves are located in isolated areas of the country, and the Chinese lack sufficient available water to capitalize on the endowments. Russia and China lack the technological expertise to do so. Activity in Argentina's shale regions has been delayed for years by political issues. Finally, institutions will hinder or delay exploration of oil shale in China, Russia, Europe, Africa and Latin America. Institutions governing property rights to subsurface hydrocarbons are favorable to exploration and development in the U.S. because the rights to oil on private lands reside in private hands and are clear and easily transferable. This is not the case in most of the rest of the world.



World Oil Production
(million barrels a day)

Note: Figures include crude oil, shale oil, oil sands and natural-gas liquids.
Source: 1950-64, compiled by Worldwatch Institute from U.S. Department of Defense and U.S. Department of Energy data; 1965-79, British Petroleum, Statistical Review of World Energy 2014; 1980-2013, Energy Information Administration
The Wall Street Journal

Consider, for example, that in China hydrocarbons mineral rights (as well as in most Asian and African nations and some European nations) belong not to private landowners, but to the state. This stands in sharp contrast to the U.S., where rights to minerals (including hydrocarbons) are, except on government-owned lands, vested in private hands. Private ownership of these rights is conducive to fracking in the U.S. But, public ownership of these rights in China has created excessive regulatory confusion and conflict between regulatory bodies.

In particular, the National Development and Reform Commission (NDRC) and the Ministry of Land and Resources have been engaged in an ongoing dispute over whether shale can be classified as a mineral or as an energy resource. This above-ground impediment to shale production is an indictment of federal ownership of minerals. It demonstrates how the ambiguity of Chinese regulatory authority prevents market forces from operating efficiently and therefore imposes ballooning cost uncertainties. [footnote] Based on output from the 18th Third Plenum, China has indicated that it is in the process of converting more extensive property rights to rural farm owners; however, the country is thus far unwilling to relinquish full mineral rights to its civilians.
Sandalow, D., Wu, J., Yang, Q., Hove, A., Lin, J., (2014). Meeting China’s Shale Gas Goals. Available from: (http://energypolicy.columbia.edu/research/shale-gas-development-china).

The emergence of large shale oil and gas deposits is altering worldwide energy markets in many ways:

1. It undermines the position of Russia and Mideast as major suppliers of hydrocarbons.
2. It weakens the worldwide market for biofuels made from sugar, corn, palm oil and wheat. In 2010, world biofuel production decreased for the first time in ten years.
3. It undermines the case for nuclear power, already shaky after the Tsunami and melt-down at Fukushima in March 2011, and the subsequent German government decision to forego all nuclear power by 2025. (China, however, was making massive investments in nuclear power in the years 2010-2015.)

Another important change that began in the latter years of the 20th century has been the growing importance of national oil companies in emerging nations.

National oil companies (NOCs) in emerging nations in 2010 controlled nearly 90% of oil reserves in the world. All of the NOCs are state-owned enterprises (SOEs), and some of them are among the biggest in the world: Aramco/CNOC/Petrobas/Pemex. Being SOEs, they exhibit many of the problems of SOEs, especially X-inefficiency (failure to minimize costs) and corruption.

Another significant change in the worldwide picture has been the very rapid growth of oil consumption in most emerging nations. Their market share in total global oil consumption has increased notably since 1996 from 33% in 1966 to 37% in 2009.

Finally, on the production side, the Chinese presence in overseas oil and gas sectors in emerging nations has been growing rapidly, especially in Africa. China by 2015 obtained more than 1/3 of its oil from Africa.

The energy resource coal is discussed only briefly in this module. Coal production is still sizable in a few emerging nations, including China, Colombia and India. And, utilization of coal remains in 2015 an important fuel in electric power generation, especially in large emerging nations, including China and India. However, the relative reliance on coal as a fuel is slowly but steadily declining in relative importance, especially owing to cheaper natural gas and gradual but promising increases in capacities for wind and solar power generation. But, the principal reason for longer term declines in coal's share in power generation is the significantly greater emission of CO_2 from use of this resource. It is a safe bet that both the absolute number of coal mines and the number of coal-fired power stations will diminish.

Alternative Energy Sources

In the long term, alternative energy sources such as wind and solar hold out great promise as fuels and as a means of reducing greenhouse gas emissions from coal-fired power stations and widespread reliance on oil in transport and electric power. This is so not only in emerging nations, but worldwide. There have been especially high hopes for a very sizable expansion in wind power. Surprisingly to most the nation with the most installed capacity in wind power in 2012 was the U.S., at 33%. Germany was next with 26%, followed by China with 25%, and then India with 11%. No other emerging nation had as much as 10% of capacity. And, in all cases, wind energy has been heavily subsidized by governments.

Another alternative energy source is hydropower. Hydropower is very important in Quebec. Much of this is exported to the U.S. In the U.S., after more than a century of investing in hydroelectric power, hydropower constitutes only 7% of electricity generation. The future of hydropower in emerging nations is briefly considered later in this module.

All other alternative renewable fuels, such as solar, constituted only 3% in the U.S., while oil and gas, at 80%, remains dominant.

Solar power is one source of alternative energy that is finally beginning to grow. At the end of the 20th century the cost of solar power was prohibitive; solar could be installed only in presence of huge subsidies. However, technological change in past few years has sharply reduced the cost of deploying solar power, which is gradually becoming more competitive with oil and gas as an energy source.

Consider also nuclear power – another option for emerging nations. The picture is different in the U.S.: new nuclear power plants will not be coming on stream very soon. In 10 years, the U.S. could not complete the construction of even one nuclear plant, even if the cornerstone were laid today. However, China has in recent years embarked on a program involving significant increases in nuclear power capacities. And, options for other emerging nations may be changing soon with the emergence of smaller and less costly nuclear reactors.

Primer on Semi-Sustainability

We will see that only a portfolio approach, including several tools, will help resolve long-term energy issues and enhance prospects for sustainable energy use. There are no magic bullets, no panaceas.

For the long run, nations rich and poor are seeking, for economic and econological reasons, to pin their hopes on increasing reliance upon alternative energy technology – wind/solar, nuclear/tides/bioproduced fuel, not ethanol from corn. However, by 2018 under the best of conditions alternative energy technology will contribute at most 10%-20% of total U.S. energy consumption and no more than 20%-25% of world needs. And, this 20-25% includes energy made from wood chips, especially in Europe. And, we have seen that this is not any kind of environmental positive.

In emerging nations, there is (except in a few cases) little wind/solar yet, but there is some geothermal and hydro. For the world as a whole, alternate energy in 2012 was only 13% of the total. Wind energy a decade ago was totally uneconomic at a cost of 80 cents kWh. It is now less than 10 cents kWh and still falling. New solar arrays are bringing solar costs down rapidly also (Houston, Texas inaugurated a new solar plant in 2011) such that solar costs now range between 17 cents to 29 cents per kWh (which is still not competitive with fossil fuels).

More generally, reliance on nuclear power will be waning notably over the next 25 years, even though China and Britain are continuing to build reactors. Almost 200 nuclear reactors are due to be shut down by 2040, according to the annual report of the International Energy Agency. The plans for reactor shutdowns over the next 25 years contrast sharply with that of the period 1974-2014, when only 10 reactors were decommissioned.

We lack the space to discuss in detail many of these very interesting alternative energy resources. It can be said, though, with a very high degree of assurance, that ethanol from corn or almost any food crop is not an answer to any intelligent question. Nor is biodiesel, except for that made by using algae. As we noted before: ethanol from corn (as in the U.S.) involves very little if any energy gain and precious little environmental gain. Making ethanol itself requires lots of energy. Also, a gallon of ethanol is less useful in internal combustion engines. This is because ethanol is a 2-carbon molecule. Gasoline is a long-chained molecule with almost 50% higher energy content.

To replace half of diesel fuel use in U.S. with biodiesel would require many millions of acres of cultivation of corn in U.S. and Brazil. The truth is, the negative environmental consequences of ethanol from corn were never considered by Congress in the rush to subsidize it. Example: pouring on fertilizer in Iowa to grow more corn for ethanol has resulted in more pollution of many rivers, especially those draining into the Gulf of Mexico.

Perspectives on Energy Worldwide

- The nations that consume the most energy per capita are #1 Qatar, #2 Iceland and #3 the U.S.

- The nations that have the lowest per capita energy consumption are #1 Bangladesh and #2 Eritrea. All of the lowest 10 are very poor.

- The countries with the highest total energy consumption are #1 the U.S. and #2 China, and Chinese consumption is likely to surpass the U.S. by 2015.

- The country with the highest gasoline prices is Eritrea.

- The nations with the lowest gasoline prices are #1 Venezuela and #2 Iran.

- The U.S. state with the most installed wind capacity is Texas, with double the capacity of California, in second place.

Energy Utilization and Energy Subsidies in Emerging Nations

Subsidies to fossil fuel use in many emerging countries are unusually high, leading to extraordinary rates of growth in energy consumption and heavy stress on government budgets. And, according to one estimate, subsidies on energy use worldwide were responsible for 36% of global carbon emissions between 1980 and 2010.[footnote] Subsidies often lead to unexpected outcomes. Over the past 30 years, Indonesia among many other emerging nations has used heavy subsidies on gasoline, diesel fuel and kerosene. The subsidies resulted in artificially low domestic prices for these products, so that consumption grew at very rapid rates. Indonesia in the 1970s, 1980s and 1990s was a major oil exporter, and a charter member of OPEC, dating back to the mid-sixties. By 2012, Indonesia, as a result of very low prices

for domestic energy use, was a net oil importer, and no longer a member of OPEC.
Pump Aligning, Economist, January 17, 2015, p.70.

And, with deeply underpriced energy in Venezuela, there has been very rapid and unsustainable rates of growth in energy consumption. By 2013, subsidies to domestic consumers of fossil fuels reached $28 billion, or more than 7% of GDP, a far greater percentage than expenditures on education or health.

Some believe that the demand for energy for vehicle use is very inelastic even in the longer run, so that higher prices for gasoline and diesel fuel would have little effect on consumption. Experience worldwide clearly shows that this is not true. Rather, heavy subsidies on fossil fuels lead to very significant overconsumption. Any doubts as to this fact may be easily dispelled by comparing the pattern of fossil fuel consumption in the Gulf States of the Middle East with that of the rest of the world. These countries are major producers of oil: Saudi Arabia, Kuwait, Qatar, Bahrain and the United Arab Emirates. All of these countries have had deeply underpriced gasoline and diesel fuel for nearly a half century. While they have only about 1% of the world's population, inhabitants consume 5% of global oil supplies annually. [footnote] This is because the heavy subsidization has caused consumption of fossil fuels in this region to grow at 8% per year since 1972, compared to only 2% for the rest of the world.
Jim Krane, Guzzling in the Gulf, Foreign Affairs, November 2014.

While heavy subsidies on energy consumption have been near universal among other nations as well, including such emerging ones as Nigeria and Venezuela, several developed nations.

However, many countries including the United States also subsidize consumption of fossil fuels, typically in the form of gasoline and diesel fuel taxes that are much lower than the marginal cost of road use. But, in rich nations, these subsidies amount to only about $25 billion per year, or about $25 per capita. Poor nations (in 2007) spent $310 billion on such subsidies.

Per capita subsidies for energy consumption in many emerging nations have been quite substantial, as shown in the Table below.

Country	**Per Capita**
Saudi Arabia	$1,036
Iran	$ 786
Venezuela	$ 647
Russia	$ 359
Indonesia	$ 102
Average for all developed nations	$ 25

Per Capita Subsidies for Energy Use (2011)

Subsidies also constitute a sizable share of GDP in nearly a dozen other nations, ranging from 11% or more in Bahrain, Egypt, Iran and Ecuador, and as low as 2.5% in India or 2% in Mexico (see the table below).

Country	**Subsidies as % GDP**
Bahrain	12.5 (2013)
Egypt	11 (2011) 6.5 (2013)
Ecuador	11 (2011) 6.5 (2013)
Venezuela	7 (2013)
India	2.5 (2013)

Iran	11.5 (2011)
Jordan	4.5 (2013)
Kuwait	9 (2013)
Mexico	2 (2011)
Morocco	4 (2013)
Saudi Arabia	7 (2011)
Tunisia	4 (2013)
Source: *The Economist,* Various Issues 2011, 2013.	

Fossil Fuel Subsidies (11 nations as percent of GDP (2011 and 2013)

Subsidies are usually justified by the claim that they help poor consumers of fossil fuel. As shown below, this claim is incorrect. But, we do know that subsidies vastly increase fossil fuel consumption and pollution, through their effects on encouraging greater vehicle use. Also, the subsidies contribute to the growth of greenhouse gasses from combustion of fossil fuels. Subsidies are also very expensive in the public budgets of nations that use them.

Consider in more detail the experiences of Mexico and Indonesia.

Mexico uses monthly price ceilings to subsidize consumers of gasoline and diesel fuel. This results in a subsidy to gasoline and diesel consumption. The subsidies since 2006 have averaged about 40 cents a gallon (U.S.$) for gasoline and about 59 cents a gallon for diesel.

The Mexican government has maintained that the subsidy is necessary to protect the poor from higher fuel prices.[footnote] The subsidy does not begin to satisfy its objective. According to 2010 Mexican data, the poorest 2 deciles in the income distribution had only 3% of gasoline and diesel consumption.

“Getting Prices Right: Mexico’s Fuel Subsidies”, Federal Reserve Bank of Dallas, *Southwest Economist*, October 2013.

On the other hand, the top two richest deciles consumed 58.5% of gasoline and diesel. So, nearly 60% of the 96% subsidy goes to wealthy households. The subsidy clearly has no earmarks of a pro-poor program.

In Indonesia, for many years over the past 3 decades, the subsidy to domestic consumption of fossil fuels has been very high, in other years somewhat lower. The low years were always the years right after Indonesia increased prices of gas and diesel, indicating significantly high price elasticity of demand.

In some recent years, the Indonesian subsidy has amounted to as little as 13% and as much as 20% of government spending: one-fifth of a budget that cannot be spent on human capital formation, infrastructure or poverty reduction. In recognition of the problem, the Indonesian Government in early 2014 increased fossil fuel prices 44% to cut the annual subsidy bill to $20 billion. Then in November of the same year, prices were again increased by another 30%.

In Venezuela, fuel prices are capped at less than U.S. 10 cents per gallon, and the energy subsidy costs 7% of GDP (see the table above titled: *Fossil Fuel Subsidies*).

Worldwide, the International Energy Agency (IEA) estimates that in 2010, government spending on subsidies for consumption of fossil fuels amounted to about $408 billion. Of this amount, only $35 billion of worldwide energy subsidies benefitted the bottom 20% of the income distribution. The poorest two deciles received only 9% of total subsidy.[footnote] Other research confirms this pattern. According to the International Monetary Fund (IMF) only 7% of total fuel subsidies go to the poorest 20% of households, while 43% goes to the richest 20%.[footnote] The reader should ask:
“Getting Prices Right,” Mexico’s Fuels Subsidies, Dallas Fed, *Southwest Economist*, October 2013.
“Fueling Controversy,” *The Economist*, January 11, 2014.

Is this good income distribution policy?

Is this good resource allocation policy?

Is this good policy for reducing greenhouse gasses?

Is this good environmental policy – does it help reduce air pollution?

The answer to each of these questions is clearly no. If governments are concerned with the effects of fossil fuel purchases on poorer families, fuel subsidies are decidedly inferior to cash transfers to the poor, to enable them to better shoulder the costs of higher fuel prices. Cash subsidies for this purpose have been utilized since 2011 in Uganda and Iran.

The inefficacy and inequity of fossil fuel subsidies is clearly evident. Still, even by 2014, large subsidies on the domestic consumption of fossil fuels continue to be used in many nations.

Fuel subsidies in Egypt have resulted in prices of fuel that are less than the cheapest bottled water. As a result, subsidies amounted to $17 billion in 2011, or about 11% of GDP. Fuel subsidies in Nigeria were fully 20% of the Federal Budget in 2011. The government of Brazil compels the SOE Petrobras to cap fuel prices at levels well below their costs of production. When subsidies are reduced by increases in fossil fuel prices, as in 2014, the changes have tended to be minimal. In that year, Brazil increased diesel prices by 5% and gasoline by 4%.

However, in spite of past timidity in reducing subsidies, a corrective trend has been developing. Other countries that have used heavy subsidies on energy include Indonesia, Ghana and India (diesel fuel only). These nations in 2014 were all in the process of phasing out subsidies. The Philippines, Malaysia, and Uganda also have sharply reduced fuel subsidies in recent years, as did Iran in 2014. The Ugandan and Indonesian programs are especially notable because they cushioned adverse impacts on income distribution by subsidies with cash payments to the poor, much like the conditional cash transfer programs used so successfully in Brazil and Mexico to reduce poverty and promote human capital formation.

Nevertheless, worldwide, fossil fuel subsidies rose sharply from 2008 to 2012, reaching $400 billion in that year. Since then, owing partly to policy

changes in Ghana, India, Uganda and Iran the cost of subsidies worldwide has declined slightly, amounting to about $375 billion in 2014,[footnote] of which 83% was due to emerging nations.
Source: “Price Squeeze”, *The Economist*, June 14, 2014.

Future Sources of Hydrocarbons for Emerging Nations

By 2025 with only one or two exceptions, the large state-owned oil companies in emerging nations will, in all likelihood, not find and develop large new oil and gas reserves. State-owned firms in Russia, Mexico, Venezuela, Indonesia, and India lack the technology and often the capital to locate and extract oil in shale formations or in deep onshore or offshore reservoirs. The possible exception could be Petrobras in Brazil. There, large, promising new deep–water discoveries have been made. These are the famous pre-sal deposits, lying as deep as 10-12 thousand feet below the ocean floor (pre-sal means deposits hidden under very thick layers of salt). Until about 2005, oil exploration technology could not detect these deposits. This changed with advances in seismic methods of exploration. If all these deposits are ever tapped, the results will provide huge amounts of natural gas for Brazil.

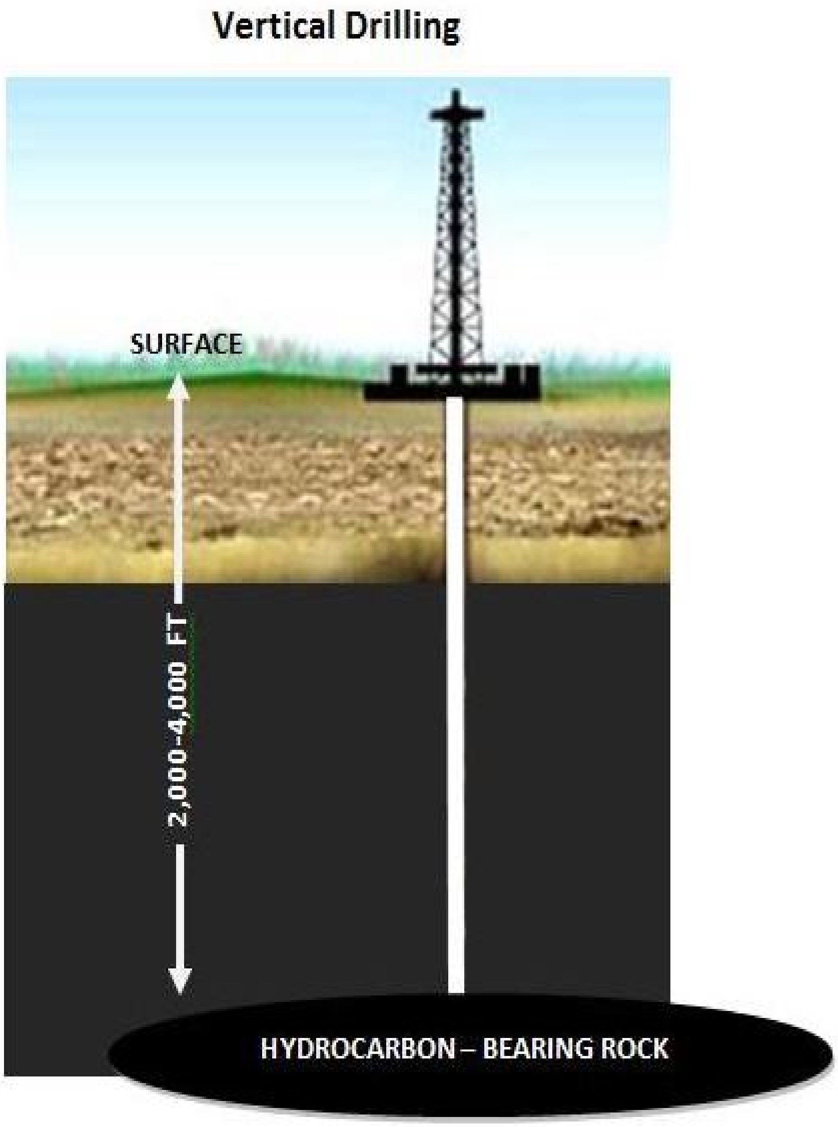
In any case new technologies furnish the best hope for finding and exploiting oil and gas deposits under the soils or seas of emerging nations. Two such technologies are presented here: horizontal drilling coupled with hydraulic fracturing of deposits (“fracking”) and new techniques for reaching deepwater oil deposits.

New Technologies: Horizontal Drilling and Fracking

For oil wells drilled in the 20th century, going back a hundred years, 60-70% of oil in deposits was typically left behind. Recovery of oil in reserves ranged from 25% to 40%.

There are thousands of these older wells all over the world, especially within the U.S. and Mexico – 23% of abandoned wells are in Texas. Under the technology of the 1960s, 1970s and 1980s it was not worth going after the left-behind oil. These old wells need 21st century methods to cough up their treasure. That is happening on a major scale, owing to technological change.

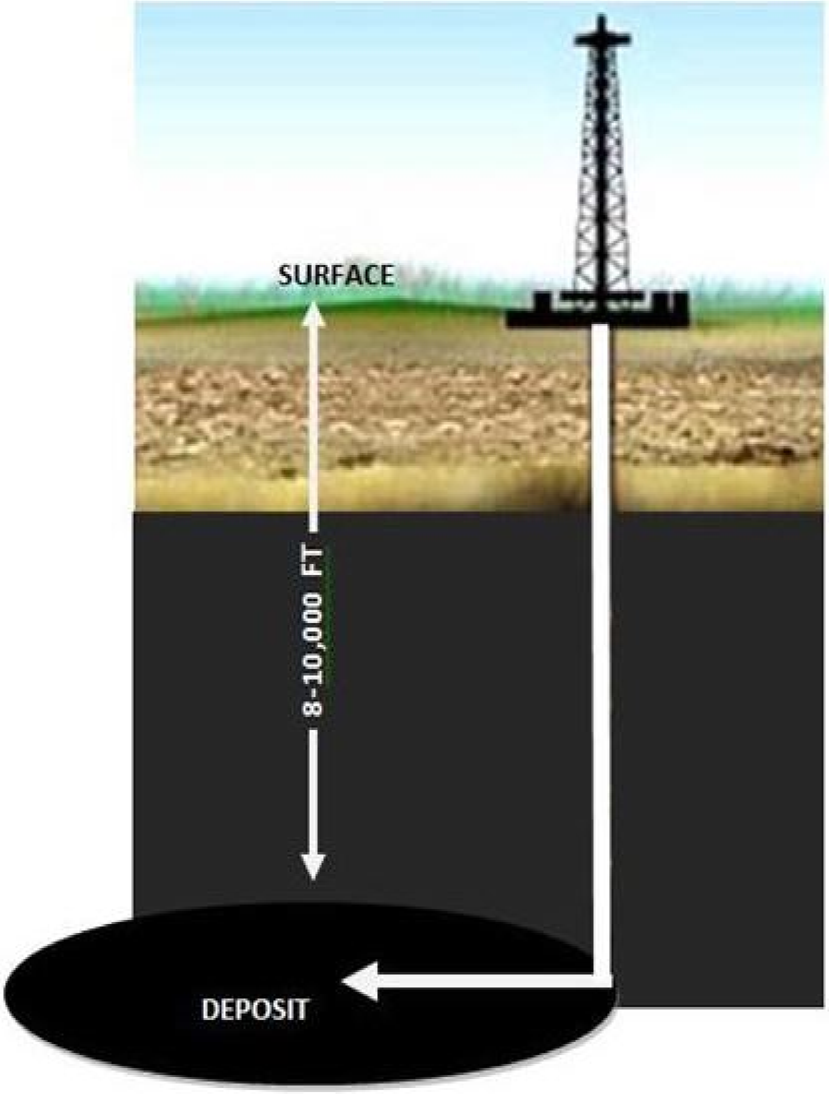
Contrast old technology with new drilling technology. Bear in mind that subsurface oil does not lay below the surface in pools but is contained in rock and/or sand. From the 1950s to the 1980s virtually all drilling was vertical. The wellspring would penetrate a hydrocarbon deposit in one location only (see Figure 15-2).



Recoveries of available hydrocarbons in such deposits were 25%-40% at best. But, two technologies in use before 2000 were combined in 2003. These were:

- Directional drilling (includes horizontal drilling) (see Figure 15-3)
- Fracturing ("fracking", to break open deposits so that the contained oil (or natural gas) will flow more readily to the wellspring).

It helps to understand directional drilling and fracking if one knows that the success of these technologies is heavily IT based, requiring very advanced graphics. Directional (horizontal) drilling made it possible to extract oil from the entire length of the deposit, rather than one in the vertical plane.



Directional (Horizontal) Drilling

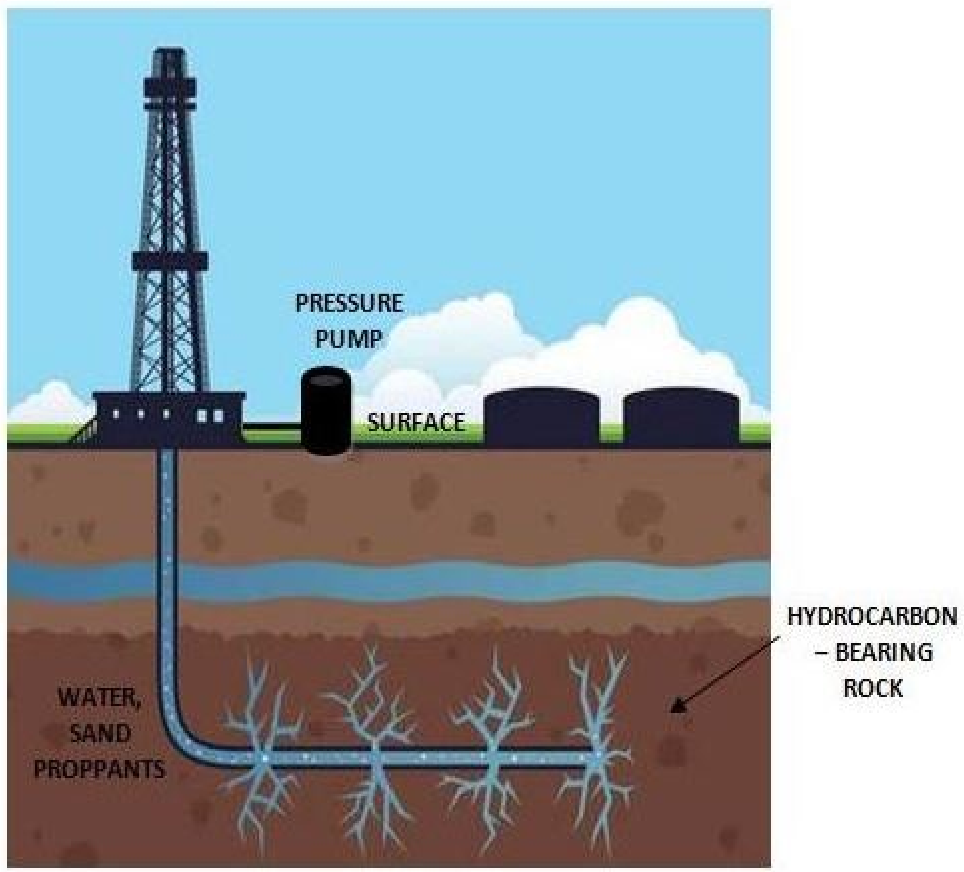
It is easy to see that with horizontal drilling much more of the reservoir is accessible to the driller.

Now combine fracking with directional drilling. Fracking has been used for decades in some U.S. formations, but on a limited basis. Only in about 2007-09 did drillers begin to use it together with horizontal drilling, first in the Barnett shale formation in North Texas. The shale revolution now underway consists of tapping “tight” shale rock with directional drilling and hydraulic fracturing to yield substantial oil and gas not available with previous technology.

In fracking, the operator pumps water (fresh or salt) and sand at extremely high pressure into the formation (see Figure 15-4). This breaks up the rock, so as to initially free the oil (or gas) to flow to the wellspring. As discussed later in this module, very large quantities of water and between 7 million and 20 million pounds of sand are required for fracking each well.

A proppant such as sand is added to the fluid and the sand in increasing amounts to "prop open" the fissures caused by fracking, allowing more oil (or gas) to flow up the well string to the surface.

Fracking on a large scale first became feasible when international oil prices exceeded $75 per bbl. Technological progress in 2013-2014 has sharply improved the productivity of fracking. For example, in June 2013 average fracking operations needed a crude oil price of $70 per barrel to be profitable. By October 2014, the average well required only $57 per barrel to be profitable.[footnote]
Financial Times, October 23, 2014, p.18.

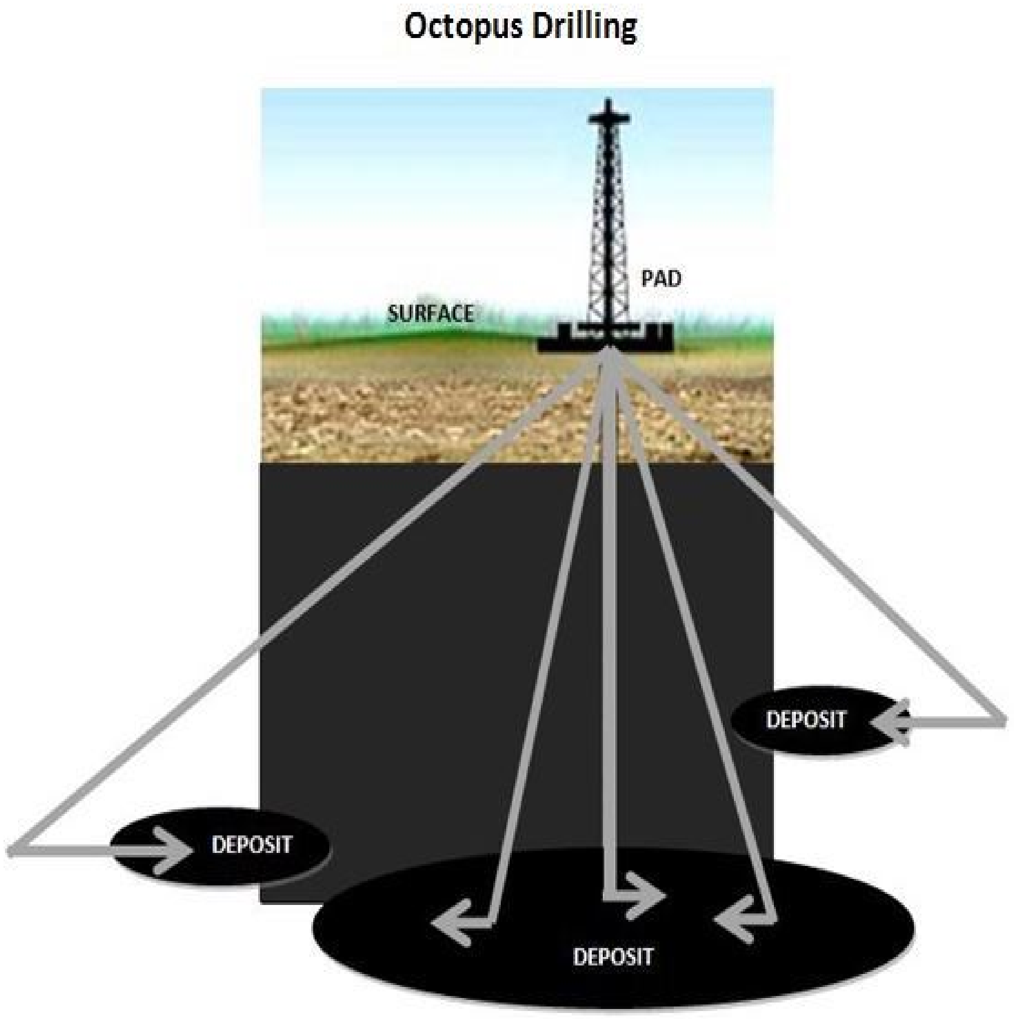


Horizontal Drilling, Fracking with Pressure Pump

With fracking and horizontal drilling, recovery from a deposit can be much higher than previously possible. Even more recent technological changes have increased both the efficiency and the reward from extraction of hydrocarbons from deep shale deposits. One example is octopus drilling.

Octopus Drilling

Octopus drilling (see Figure 15-5) combines horizontal drilling and fracking with multiple wells on a single pad, or platform, to tap multiple deposits. This has made drilling faster and more efficient and has bolstered recovery rates even further. With octopus drilling, there can be as many as 18 wells emanating from one pad, enabling oil firms to secure even larger columns of oil or gas from shale deposits.



Octopus Drilling

By 2014, the Eagle Ford formations in South Texas were producing nearly 2 million barrels per day; double that of the rich Bakken shale formations centered in North Dakota. Under the methods presented above, Texas will likely produce 4 million bbls per day by 2020, or double that of Nigeria in 2013.

In tight shale formations, decline curves have tended to be very steep. That is, initially the volume of oil (and/or gas) comes in strong, but then drops off. The decline rate in a single shale well can be as high as 60% in the first year, continuing on into the second and third years at increasing rates each year.

To see the significance of this, consider a typical type of well drilled in the Texas Eagle Ford Shale (a formation, not a location) where the northern portion of the formation yields primarily crude oil, while the southern portion yields mainly natural gas. Marcellus shale formations in the U.S. North East produces mostly gas. Compare this with a “noble” oil well in Angola or the huge Saudi Sheba Field, located near Bahrain.

These “noble” wells in the Middle East have produced 15,000 to 20,000 bbls of oil a day in the first year of production. After that, output falls by about 20% in the first four years of operations (about 4.5% decline per year).

But, in the Eagle Ford Shale in Texas, a well might produce only a few hundred bbls per day in the first year, with a decline rate of about 7.5% per year thereafter. This is why over 12,000 wells have been drilled in just 3 Texas locations since 1999 with perhaps 100,000 new wells nationwide.

Decline rates differ significantly in different shale deposits. In the Bakken Shale in North Dakota, a typical well loses 44% of its production after a year. To counter the rapid decline rates, drillers have resorted to “octopus” drilling illustrated earlier.

It is for this reason (rapid decline rates) that U.S. production of crude oil is expected to increase from 5.82 million bbls. per day to a peak of about 7.54 million bbls. per day in 2019. Then, as shale fields mature, crude production is expected to fall to 6.13 million bbls. per day within a few years. Some oil industry leaders say that while very welcome, shale oil is a temporary bonanza for the U.S. So even if the U.S. becomes the world’s largest oil producer and a leading natural gas producer by 2019, this will not mean U.S. energy independence forever (as some think).

Rapid decline rates in shale wells are not only reasons for caution in predicting U.S. oil independence over the next few years. Fracking as practiced in the U.S. is expensive ($5 million per well and up). High prices, reaching a peak of over $120 per barrel (2014) have attracted high investment levels in shale-bearing regions. Fracking operations turn out to be quite sensitive to oil prices. From June 2014 to mid-November 2014, oil prices per bbl (Brent prices)[footnote] fell by 30%, to $82.00 and then to

$62.00/bbl in mid-December. The International Energy Agency predicted that this price decline, if not reversed, could lead to a 10% decline, at least, in U.S. shale investments in 2015. This would eventually place at risk any sustained energy independence for the U.S. By January 2015 the price of Texas crude had fallen to $48.00/bbl. Even if oil prices were to fall below $50/bbl, wells that are already in place would continue to produce, because capital costs have already been sunk. Operational (variable) costs lie well below $50 for all but the most inefficient firms. Operational costs of independent drillers in 2014 averaged less than $20/bbl. This, even at $50/bbl oil, would continue to flow from wells already in place, but at the rapid decline rates noted above.

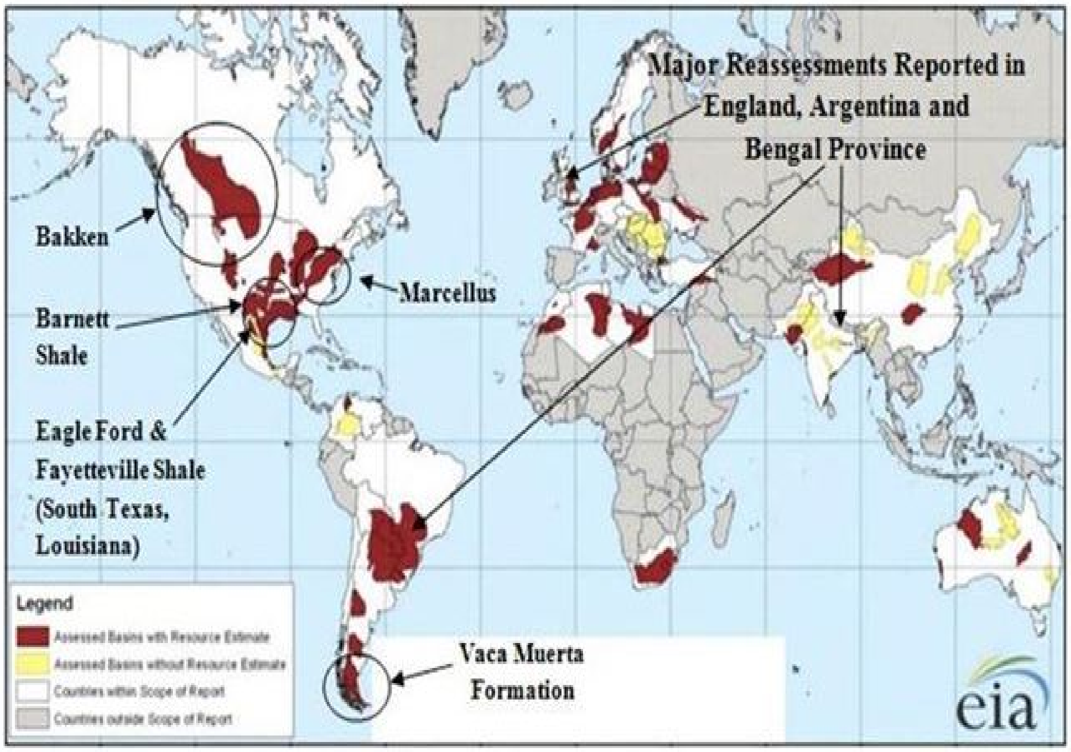
The reader should be aware that there are two distinct benchmark prices for petroleum: the Brent price and the price for West Texas crude. The Brent price (named after the Belgian port) is typically used in reference to prices in Europe, Africa, South Asia and parts of East Asia. The West Texas crude price is ordinarily quoted for U.S.-source crude.

The Brent price is typically 10% to 15% above that of West Texas crude. In July 2014, the Brent price was $115 per barrel, versus $106 for West Texas crude. Both prices dropped sharply by December 2014: the Brent price was $60/ bbl, while that for West Texas crude was $55. This figure is based on a sample of operating costs in eight large independent firms. Some firms, however, have costs exceeding $40/bbl. The sample is cited in the Economist, December 6, 2014. p.81.

In any case, it is apparent that the combination of the innovation of directional drilling and octopus drilling with changes in fracturing practices that has been responsible for the huge recent increases in gas and oil output reserves in the U.S. and elsewhere, especially from shale formations.

By 2015 the shale boom in the quest for hydrocarbons has hardly begun in the rest of the world, especially in emerging nations (see Figure 15-6).

Global Shale Plays


Major Reassessments Reported in England, Argentina and Bengal Province
Bakken
Marcellus
Barnett Shale
Eagle Ford & Fayetteville Shale (South Texas, Louisiana)
Vaca Muerta Formation
Legend
Assessed Basins with Resource Estimate
Assessed Basins without Resource Estimate
Countries within Scope of Report
Countries outside Scope of Report
eia

-22,600 TCF of Recoverable Reserves
6600 TCF from Shale (40%)
Current use – 160 TCF/year

Source: Energy Information Administration. (2011). Report *World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States.*
Retrieved from http://www.eia.gov/analysis/studies/worldshalegas

The reader may wonder why the discussion on shale, directional drilling/fracking has been presented in such detail. There is in fact, a very good reason. These developments have already begun to materially change the world energy picture, not only as it pertains to developed nations, but to emerging nations as well. Notable environmental risks may also be involved, but that is not all. The reverberations from shale will resound down through the next 30 years, and will affect the lives of hundreds of millions worldwide.

Suppose U.S. shale deposits began to peter out after, say 2025 or 2030. Energy from shale deposits elsewhere in the world will likely continue to flow after 2030 even if fracking bans continue in France, Vermont and New York.

Consider the world map on shale plays.

At some point, China, Argentina, Libya, Brazil, Russia, Bolivia, and South Africa will begin exploiting their shale reserves with the help of foreign oil companies. This growing supply would mean that world energy prices would tend not to rise significantly over the long term, resulting in continued significant erosion of the Middle East and Russia in influence on energy.

Fracking and the Environment

Exploitation of shale plays has not been without controversy, to say the least. France banned fracking entirely in 2011. New Jersey and Vermont also prohibit fracking, even though they lack shale deposits. New York, under which lies part of the Marcellus shale formation, banned fracking in 2014. Other European nations were considering limits to fracking as well in 2014. In the U.S. in 2012 three towns in Colorado imposed a moratorium on fracking, as did North Carolina and New York. Thus far, no emerging nation has imposed bans or moratoriums on fracking. On the contrary, several, such as Argentina and Mexico in 2014, offered new incentives to foreign drillers to enter their shale plays.

It helps to understand directional drilling and fracking if one knows that the success of these technologies is heavily based on information technology (IT), with very advanced graphics.

Those countries besides the U.S. having shale formations that bear oil or gas (see Figure 15-6) include Brazil, Ecuador, Poland, China, Russia and Colombia etc. Argentina has huge hydrocarbon reserves in the oil shale formation called Vaca Muerte (Dead Cow).

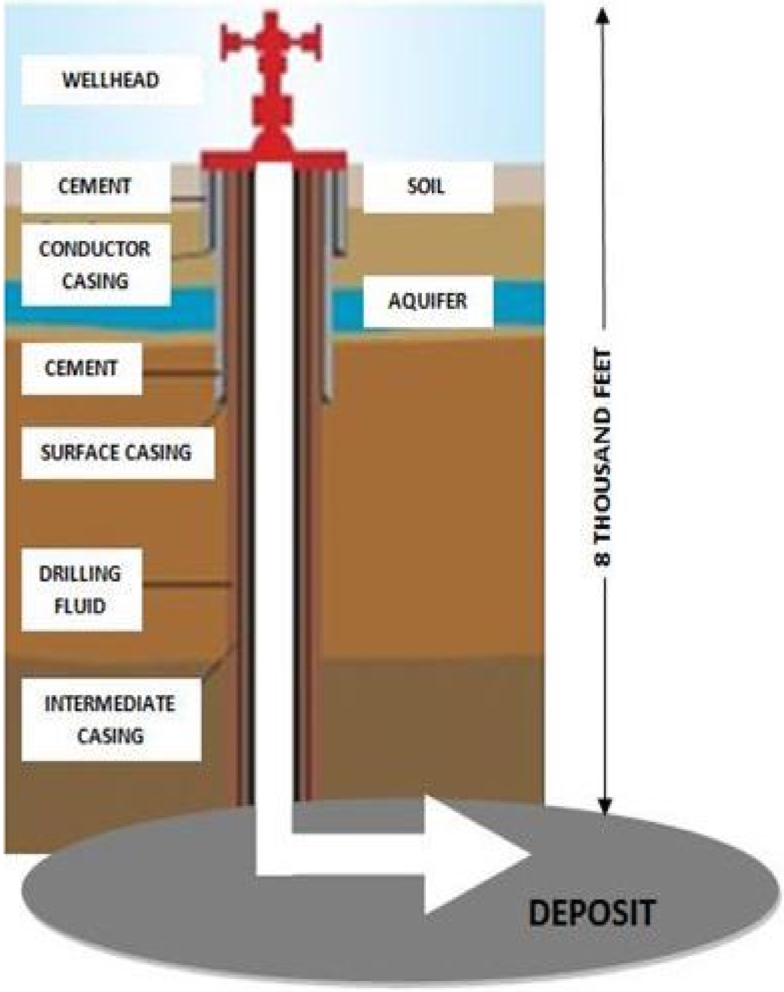
Fracking has vastly increased proven worldwide reserves of oil and gas. Before horizontal drilling and fracking, hydrocarbons locked up in shale were much too expensive to extract. But there is a price to be paid: the effects of fracking on the environment.

Up to now, virtually all experience with fracking has been in the U.S. Over the past 25 years, fracking has been employed in tens of thousands of wells across the country.

What is the environmental record thus far? There are six main issues.

1. **Stress on Water Supplies**
   The first issue involves the very large amounts of water that must be used in fracking operations. Water requirements for fracking vary according to location. But, a good illustration is that of the Eagle Ford Shale formation in South Texas. There, an average of 4.5 million gallons of water are required to fracture each well. In areas of plentiful water supplies, this may not be a serious problem. But, many shale formations lie in areas of moderate to severe stress on water supplies. This is especially so for Chinese and Mexican shale formations. This is a serious issue in a world faced with growing scarcity of fresh water supplies.
2. **Possible water table contamination from fracking (drinking water)**
   Shale deposits typically lie between 7,000 and 12,000 feet or more below the surface. The water table anywhere is rarely deeper than 2,000 feet at most. How then, could contamination of water tables result from fracking, since the water table is ordinarily so far above the shale deposit?
   Again, fracturing involves pumping downwell a mixture of water, sand and chemicals under high pressure into deep rock formations as much as 2 miles underground. The frac fluid is 99.5% water and sand. The rest consists of detergents and chemical proppants.
   We have seen that fracking creates fissures in the rock, so that hydrocarbons (gas, oil or both) flow to the wellstring. Diesel fuel was once used as part of frac fluid, but no more except for some fly-by-night firms.
   Shale gas wells are first drilled vertically from the surface, to just

above the shale formation. During the drilling of the vertical part of the well, a series of steel casings are put into place and cemented in order to protect fresh water aquifers thousands of feet above the well (see Figure 7).



Then, because the drilling pipe is flexible, it can bend and go horizontally into the formations. The horizontal portion is ordinarily not cemented, but is encased in flexible metal coil casings. Once the horizontal portion is in place, the well operator perforates the horizontal casing using shaped charges (armor piercing technology). This allows (after pumping in water, sand and other proppants) the hydrocarbon to flow into the casing, which then is pumped up to the surface.

In August 2011 a report of Secretary Chu of the Energy Department concludes that with fracking done this way, at such great depths: *"The risk of fracturing fluid leaking into drinking water sources is remote."* However, the report fails to stress that there are some regions where fracking could contaminate drinking water, or even introduce methane into drinking water. There are locations where old wells drilled under earlier technology have been improperly completed, where the requisite steel pipe and cementing was not used. Such wells are not uncommon in West Virginia and Pennsylvania. In such areas, fracking can cause methane or other contaminants to migrate to the old wells and then contaminate the water table. These old wells were primarily drilled into parts of West Virginia and Pennsylvania in the 1950s and 60s. So, the solution to this problem is clearly: ***Don't Frack There!*** Or frack there very selectively and carefully. In June 2015, according to released findings from a four year study from the Environmental Protection Agency (EPA)—the federal government's most comprehensive examination of the issue of fracking and drinking water—fracking can be carried out safely and doesn't need to pose a threat to water.[footnote] See the article published in The Wall Street Journal, authored by Russell Gold and Amy Harder, on June 4, 2015. It clearly states that while there have been some cases involving spills and leaking wells, the spread of fracking didn't cause extensive damage to groundwater resources. It noted that there were certain "potential vulnerabilities" to water supplies that needed to be addressed, including ensuring wells are well-built and wastewater is disposed of properly.

3. **Mild Earthquakes from Fracking**
   Small earthquakes, at 2-3 on the Richter Scale have been reported in some areas such as Youngstown Ohio, where fracking has been going on for some time. It is now clear that these quakes are not due to fracking but to either reinjection of CO_2 in underground formations (sequestrations) or due to reinjection of produced water into the ground, especially through old wells. Also, some areas such as Clinton, Michigan have

experienced a series of similar earthquakes where no fracking is underway.

4. **Disposal of Produced Water Used in Fracking**
   The most significant environmental issue associated with fracking is what to do with the "produced" water used in fracking. Substantial amounts of water are injected into the wells along with proppants such as sand.
   Much of this water returns to the surface with the oil or gas coming to the wellhead. In some mature fields produced water can be 10-20 times the oil produced. Sometimes this "produced" water contains contaminants (heavy metals, radioactive particles).
   In oil and gas rich Texas, 80% of water is used for agriculture. The amount of water needed to drill and frack a well is about what is required to grow 10 acres of irrigated corn. Moreover, the produced water can be recycled and treated. There are now many technologies available to do this. At least 4 such technologies were being developed at Rice University alone in 2013-2014. Already, recent technological development has allowed shale oil producers to reuse and recycle produced water. For example, in Pennsylvania about 89% of water used in fracking processes is reused or recycled.[footnote]
   At least in the U.S., there is sufficient oil and gas in shale to allow the nation to be energy independent at least through 2025. Therefore, it should not be difficult just to place all environmentally sensitive areas off limits to fracking activity.
   The 2014 Texas Water Summit Report, Austin, p.52.
5. **Impact of Fracking Activities on Road and Highways**
   Fracking requires the use of heavy equipment such as those carrying pressure pumps. And, as we have seen, heavy trucks carrying large loads of sand and water are needed for firms to conduct fracking opportunities.
   The result in regions where substantial shale deposits are present is serious damage to roads and highways. This has been especially apparent in the Eagle Ford Formation in South Texas. There many roads and highways are in serious disrepair because of heavy traffic of very heavy vehicles.
   Good resource allocation policy would require that road user charges should at least cover the marginal cost (MC) of road use. However, the

only significant road user charges (in Texas and in other States) are federal and state taxes on diesel fuel and gasoline.

The revenues from these road user charges flow into highway trust funds that are intended to be used for maintenance and repair of existing roads and expansion of the highway network. However, the proceeds from diesel fuel and gasoline taxes fell far short of sufficiency for either road repair or construction. This is particularly critical in such regions as South Texas, where road damage from fracking operations has been severe. The obvious and sensible remedy for this problem would be an increase in road user charges to cover the full costs of road use, including those for maintenance and repair.

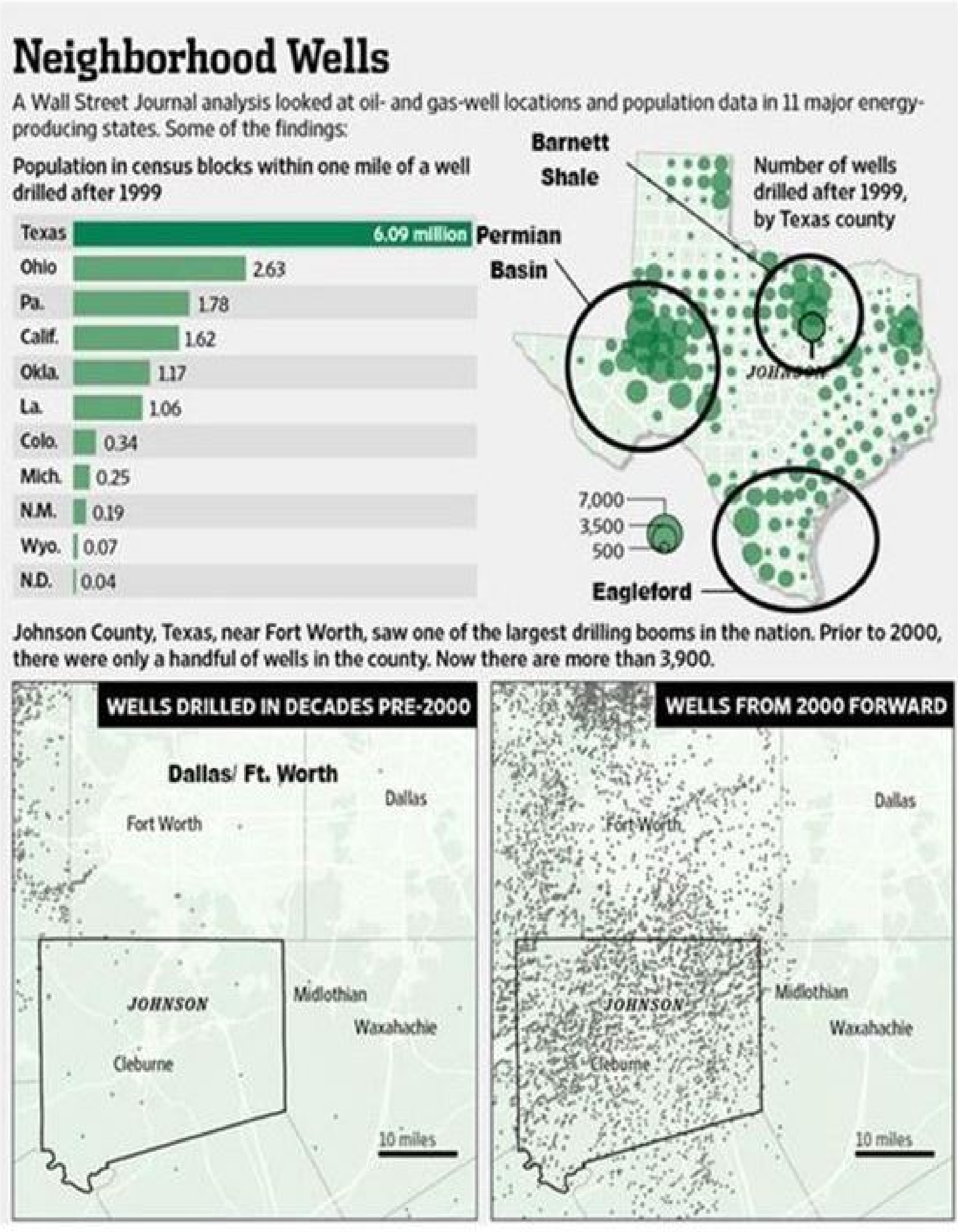
6. **Intrusiveness of Fracking Operations Near Urban Areas**

In some U.S. states the shale boom began in 2005-06. According to the Wall Street Journal, at least 15.3 million Americans now live close by a well that has been drilled recently. So now many people have oil well pads virtually in their backyards.

This pattern is especially marked in Texas, where fracking operations have been substantial in three principal areas: the Eagle Ford Formation (27 counties in South Texas), the Permian Basin in West Central Texas, and the Barnett shale near Fort Worth (see Figure 8). The population living within one mile of wells drilled since 2000 totals 6 million out of about 21 million Texans.

Is this a problem? It depends. On the one hand, in such states as Texas, North Dakota and Pennsylvania, tens of thousands of new jobs have been created in these areas and many landowners who have leased mineral rights to oil companies are now multi-millionaires.

Intrusiveness of Fracking in Texas



Neighborhood Wells

A Wall Street Journal analysis looked at oil- and gas-well locations and population data in 11 major energy-producing states. Some of the findings:

Johnson County, Texas, near Fort Worth, saw one of the largest drilling booms in the nation. Prior to 2000, there were only a handful of wells in the county. Now there are more than 3,900.

On the other hand, these operations often involve problems. One is severe road congestion. Drilling and fracking a single well may involve more than 1,000 trips by very heavy trucks to haul workers, sand, and water. This results in heavy wear and tear on the roads near

> the Eagle Ford Formation area in South Texas and the Permian basin in Central Texas.
> A second problem is that an increasing number of wells are within one mile of population centers, bringing air pollution and congestion. Consider the Barnett Shale Formation near urban Ft. Worth. As recently as 2002, only 44 wells were horizontally drilled there. By 2006 there were 1209 horizontal wells in the area.
> However, this issue is unlikely to be nearly as significant in low income emerging nations seeking to exploit their shale deposits. In Argentina, China, Brazil, Mexico, South Africa, and Northern Africa, the shale deposits are typically not close to major urban centers. Instead, lack of plentiful water for fracking and lack of domestic technology in drilling are the more important limitations on exploitation of shale for oil and gas.

Finding Energy: Deepwater Deposits

Another potential major source of oil and gas for emerging nations are offshore deposits lying under very deep water. These deposits lie under water 10,000 feet deep or more, plus another 10,000 feet under the sea bed. Rights to these endowments belong to Brazil, Ghana, Ivory Coast, Mozambique, Mexico and others.

These deepwater deposits are especially important for countries such as Mexico. Prospective reserves in deepwater and shale total 115 bbls. of oil equivalent. The largest existing Mexican oil fields, such as the giant Cantarell Field, discovered in 1976, has been depleting rapidly since 1995. As a result, total Mexican oil output has decreased by 1 million bbls. per day, at a time when Mexico has sizeable expensive subsidies on domestic use of fossil fuels, and declining volumes of exports from oil.

Four features of these deepwater assets will require emerging nations to collaborate with foreign oil companies to reap the benefits. First, exploration and development in these locations will be quite costly: upwards of $1 billion to $3 billion per project. By 2014, deepwater and ultra deepwater hydrocarbon projects totaled $66 billion worldwide. Second, the life cycle for such projects extends over 15 to 25-30 years.

Third, exploration costs will be heavy, and will be concentrated within the first 5-7 years of any deepwater project well before any sales of gas or oil. This means that initial cash flows from the undertakings will be negative, perhaps for as long as a decade. Fourth, significant price risks are involved.

The large private multinational oil companies are much better equipped to deal with market risk than national oil companies in developing nations. The former are larger and stronger financially. The private multinationals such as Chevron and Exxon take a very long-term view of prices because their investments, especially in deepwater deposit exploration and development, last not for years, but decades. The abrupt 50% fall in crude oil and gas prices in the latter half of 2014 has not materially affected the deepwater investment plans of the companies. Because these companies cannot be certain what the price of oil or gas will be when a major project finally comes on line, firms build into their business models fluctuating oil prices.[footnote]
Exxon’s business plan tests its investments across a broad range of oil prices, from as low as $40/bbl to as high as $120. (Statement of Exxon CEO Rex Tillerson, January 11, 2015).

Other than perhaps Brazil, none of the emerging nations with rights to deepwater deposits now possess sufficient capital to mount ambitious deepwater projects. For example, in deep waters in the Gulf of Mexico belonging to the U.S., over 1,600 wells have been drilled. But, on the Mexican-owned part of the Gulf, only 50 wells have been drilled. And, none of these countries, Brazil included, possess all of the technology required to successfully carry out the projects.

The life cycle of a deepwater deposit can be illustrated as in Figure 15-9.

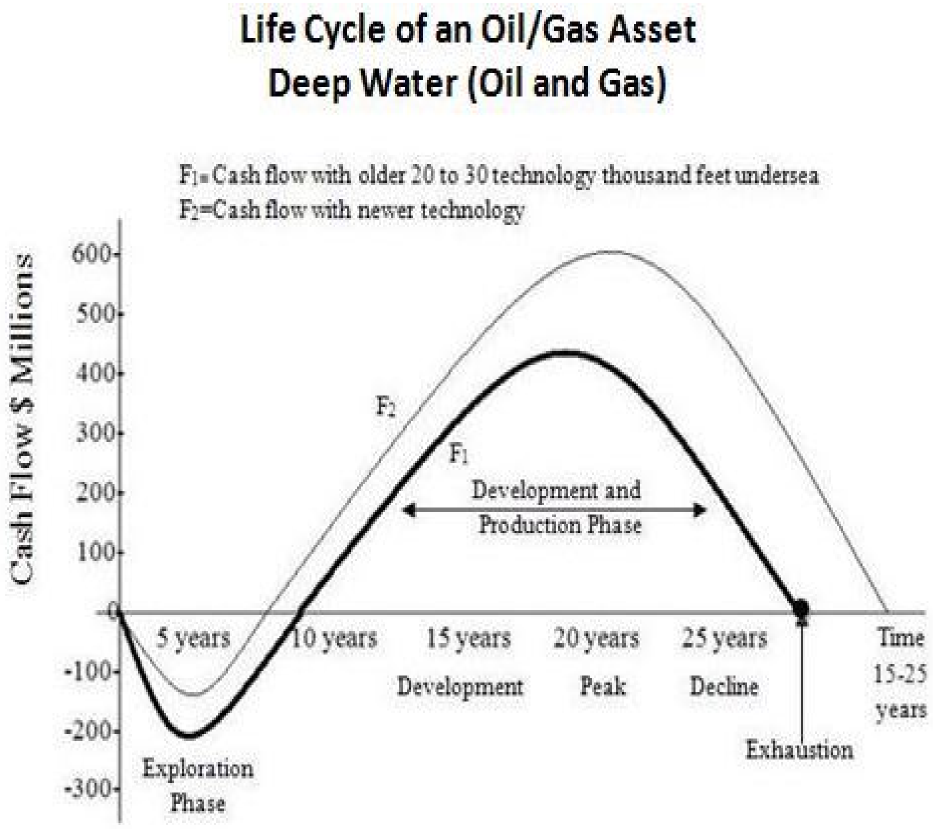


Figure 17-4 shows first the life cycle of the asset under present technology, as indicated by the curve F_1. With present technology, the exploration phase covers 10 years (with negative cash flows), while the development and production period lasts for about 15 years, up to exhaustion at about year 27.

Prospects for these offshore deposits would be greatly improved by advances in drilling technology under the difficult conditions found in very deep water.

An advance in this technology, portrayed as curve F_2, would extend the life cycle of the asset and vastly enhance financial returns: the exploration phase would be shorter, the development and production phases would be longer, and exhaustion of the deposit could be pushed out 5 years or more.

Of course, offshore drilling involves environmental risks that may cause host countries and foreign oil firms to have some second thoughts about undertaking very expensive and difficult-to-manage deepwater deposits. These risks became much in evidence after the May 2010 oil spill in waters off the Gulf of Mexico, involving British Petroleum and several other firms.

Capturing Benefits from Energy Endowments for Emerging Nations

As earlier noted no emerging nation–even those with large NOCs such as China's CNooc or Brazil's Petrobras–has the technology to tap all available hydrocarbon sources, especially the relatively inaccessible and expensive newly diverse shale and pre-sal deposits and deposits lying under 10,000 feet of salt water.

For both types of deposits, there will be for some time need for foreign technology and capital to get hydrocarbons out of shale, or out of deepwater deposits. That being the case, how can emerging nations best protect their interests in dealing with foreign firms such as Exxon, Chevron, Statoil, and Total?

One option would be to merely hire the firms to bring their exploration and drilling technology to the table and pay just for the technology. Ecuador attempted to do this in 1981. The State Oil Company asked the author to advise them on whether or not they could just pay the foreign oil companies just to bring their technology capital, but with no share of any oil produced. It was clear that this would not work, for at least two reasons:

1. Large oil companies are organized to be big oil companies. They do not see themselves as simply sellers of technology or suppliers of the billions of dollars of capital required for oil exploration and development. They seek a share of oil or gas produced. They are, after all, oil companies.
2. For many emerging nations, such as Ecuador, Thailand, and Colombia, the revenues of the oil companies are as big or usually even bigger than their GDP. That means they are better able, or at least as able, to shoulder the major risks in all oil business:

a. Market risk (what will be the price of oil internationally 2-5 years down the road, given volatile energy markets such as the world has experienced for decades).
b. Technological risk – typical oil and gas projects today run into several billions of dollars. But there is no guarantee that commercial reserves will be found when this money is spent.

The companies (Exxon, Chevron etc.) strongly prefer to have at least some title, some property rights to any oil (or gas) that may be found.

But, this has been a very unpopular position in many emerging nations, especially in Mexico, Brazil, and most of Latin America. These countries have been very wary of opening up their hydrocarbon sectors to foreigners. However, this situation is changing in Mexico, which is expected to allow foreign involvement in oil as early as 2016.

These conflicting objectives require arrangements that might be seen as a compromise.

One possibility, now widely used, is the production sharing contracts of the type pioneered in Indonesia 50 years ago and which have worked fairly well ever since.

The basic form of production sharing is quite simple:

Under production sharing:

1. The host government takes a fixed percentage (sometimes variable) of oil produced under the contract. This can be as low as 60% and as high as 85%, depending upon many factors.
2. Governments allow the foreign contactor to take a fixed percentage of the oil produced.
   And
   , the host government also imposes income tax on the net income of the company operating in the host country. This rate is almost never less than 50%.

Foreign oil firms accept these arrangements, because they

1. Provide some certainty for contract provisions
2. Allow the foreign firm to time sales of their share of oil, so as to get the best prices, and most importantly
3. The firm gets to deduct all exploration and development costs in determining net income for the income tax they must pay. So the firm covers the very heavy costs involved.

Production sharing contracts can be fine-tuned to secure about any return the government as host wants, utilizing alternative combinations of the production share split, royalty payments, or income tax rates to get for the host nation 70%, 80%, or 85% of the value of oil. Companies can bid for the rights to exploit. A host government can, however, go too far in setting terms for production sharing.

An example is the 2013 bidding for rights to exploit Brazil's apparently rich pre-salt deposits. These are super deepwater deposits under salt formations that can be quite tricky. One project involves billions of dollars in cost. In the 2013 round of bidding, the terms were so unattractive that only one bid was received, and that involved a consortium of Chinese, American, and Latin American firms.

Thus, production sharing is no panacea, but no one has yet found a better way to set contract terms on a basis that allows countries and oil firms to reach mutually satisfying agreements on oil exploration and development.

Hydropower?

One needs to be very careful about undertaking large-scale hydropower projects, anywhere. The main attraction is that hydropower can be very cheap – as low as 7 cents per kilowatt in Quebec. Costs of hydro almost everywhere can be lower than gas, coal oil, nuclear, solar, or wind.

But, there is a need to consider all costs of hydro projects.

Consider the three gorges dam in China. Rising waters in reservoirs created by the dams has displaced millions of people. These costs were not counted as a cost of the project. Elsewhere, in Malaysia and Brazil costs of relocating families from reservoir areas have been large. Even so, hydo always should be considered where there are plentiful rivers and highlands.

Consider the huge river systems of tropical Africa, especially in Zambezi, Volta, Congo, Egypt, and Sudan. There is enough hydro potential there to light up 2/3 of Africa. But, many new potential African hydropower projects tend to be infeasible because they are located well away from population centers. Losses in transportation of power over the long distance, or losses due to the buildup of resistance, can be as high as 11-13%.

Another region with substantial hydropower potential is that encompassing Nepal, Bhutan and North India. Rivers fed with Himalayan glacial melt in Nepal could furnish about 400 gigawatts (GW) of very clean electric power, or a sixth of installed power capacity in India. Moreover, the total hydropower potential of Nepal, India, Bhutan and Pakistan approaches 120 GW. This would be the rough equivalent of 240 500 megawatt coal fired electric power plants – a very sizable increase in energy availabilities involving near zero carbon emission.[footnote]
See the Economist, “Water in the Hills”, November 29, 2014.

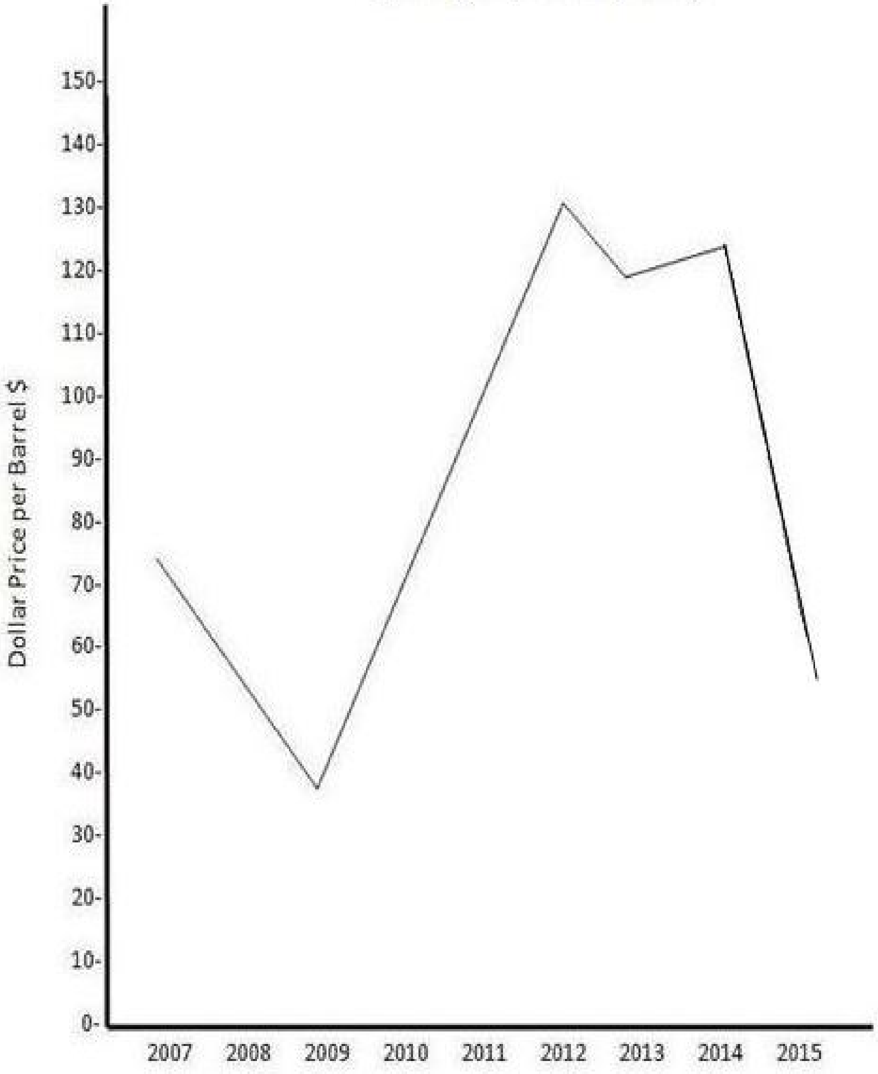
Natural Resource Markets: Volatility

The international market of oil has proven to be quite volatile. There have been bubbles (in 2012) and “busts” (2014) (see Figure 17-5 showing “Brent” prices). This high degree of volatility has notable consequences for all emerging nations, both oil exporting countries and those that must import their energy requirements. Volatility in energy markets will complicate the ability of emerging nations to maintain stable economic growth and avoid ruinous inflation.

For oil importing emerging nations managing deficits in trade and in the public budget management of both will become much more “taxing.” Why? Because energy is such a large percentage of imports and government expenditure everywhere (except for oil exporters).

But, oil exporters are vulnerable to volatility as well. For all emerging nations, large price swings in energy past and present greatly complicate efforts to control domestic inflation both in upswings in oil price cycles and in downswings. This volatility also makes it more difficult to operate effective exchange rate policies. In sum, central bankers all over the world, but especially in oil dependent Nigeria, Venezuela, Russia and Ecuador, will have a much tougher job in maintaining price stability in the 21st century than in the 20th, owing to this volatility.

International Oil Price Volatility 2007-2015
(Dollars per Barrel)
[Ranges $38 to $128]



Brent Crude Oil Price (typically about 12% higher than oil prices for West Texas Crude Oil).

ENERGY: NUCLEAR POWER

Over the past two decades there has been some largely unnoticed evolution in nuclear power installations:

1993	The U.S. was the top nuclear power producer @ 2 trillion kW-hrs.
2011	The U.S. was still the top producer @ 2.5 trillion kW-hrs.
Both in 1993 & 2011	France was the #2 nuclear power producer.
In 1993	South Korea was the only "emerging" nation in the top ten (@ 10th with 55 billion kW-hrs).
By 2011	South Korea was 5th among emerging nations in nuclear capacity
By 2014	China and Ukraine were in the top ten but only with 83 billion kW-hrs.

In recent years, nuclear power has picked up some enthusiasts. If the world ever establishes sizeable carbon taxes, the nuclear advantage over coal could be huge. But nuclear power has been under a cloud ever since the incident in U.S. at Three Mile Island in 1979. Then, we had the Chernobyl disaster in the Soviet Union two decades ago. And in 2013 the Fukushima disaster further darkened the clouds over nuclear power. Reaction to Fukushima was instant and impetuous. Chancellor Merkel in Germany announced on her own that Germany would close down German reactors by 2022, a decision that may lead to strong regrets later.

Nuclear research blossomed after 1936, when Albert Einstein sent Roosevelt a letter stating his concern that the Nazis could develop an atomic bomb.

Most of what we know about nuclear fission – for peaceful and military uses – has been developed over the past 60 years at ten Federal Energy Labs across the U.S. – including Los Alamos, Brookhaven, Sandia and Oak Ridge Lab in Tennessee. At the latter both nuclear warheads are made and nuclear energy research conducted.

My perspective on nuclear energy stems partly from the years I chaired the Visiting Committee, Energy Division for Oak Ridge National Lab. In considering nuclear energy, note that the nuclear fuel cycle is divided into three stages:

(1)	Front End	Uranium Exploration extraction, milling, refining and enrichment of fuel elements;
(2)	Middle	Power Generation: The use of nuclear fuel in a reactor; and
(3)	Back End	Management of storage and disposal of radioactive waste (and in some cases, chemical reprocessing to recover fissionable materials remaining in spent nuclear material).

We will not in this chapter discuss in detail the “Back End”. Those interested in the “Back End” of the nuclear cycle should consult the following two articles:

1. Malcolm Gillis and David Erikson, "High-Level Enterprise and Low-Level Radioactivity: Two Hazards in Developing Country Uranium Concessions", The Journal of Energy and Development, Autumn 1980, Vol. VI(1):39-60; and
2. Allison McFarlane, "The Overlooked Back End of the Nuclear Fuel Cycle", Science, September 2, 2011.

In 2013 there were about 470 nuclear power plants worldwide, producing almost 20% of world electricity. In the U.S. nuclear power provides 21.3% of total power (near the world's average).

All nuclear power at present comes from nuclear fission, not fusion. Nuclear power from nuclear fusion is an alternative for the near future. Fusion produces most of the energy coming from stars. Fusion would be extremely attractive because it would be incredibly cheap, it would be much safer than fission reactors, and there would be almost no problems of waste disposal.

Fusion power has long been one of those developments that are "just around the corner". I first heard in 1970 that fusion power was only ten years in the future. In 1980, I heard that it was ten years in the future. As late as 1990, the claim was again that it was ten years in the future.

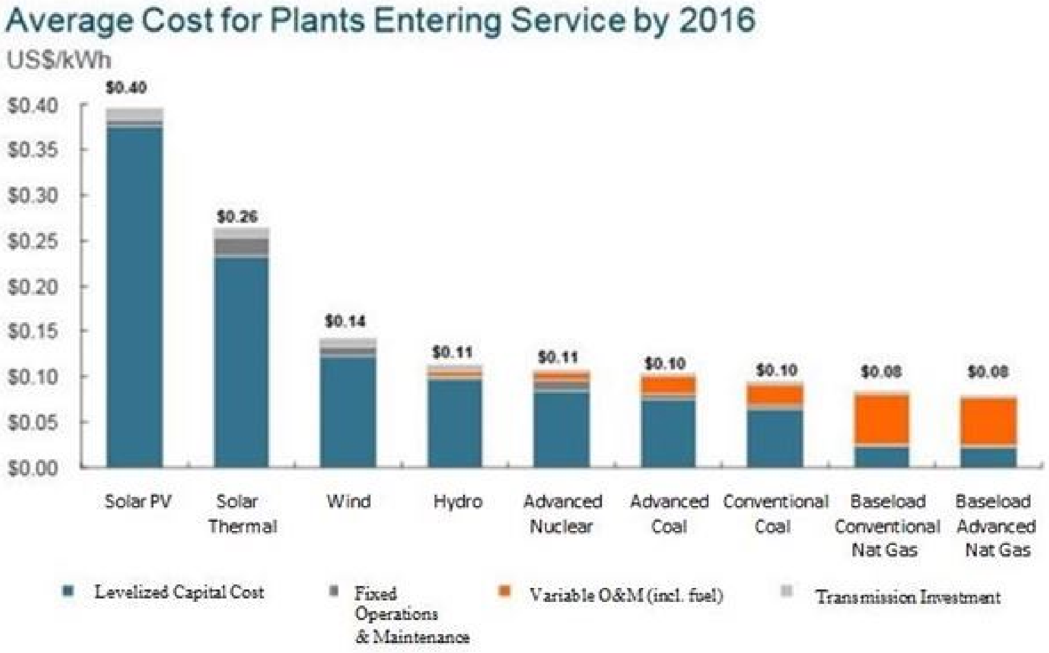
The principal problem is the incredibly high temperatures of the plasma involved in fusion reactors. There are machines in the U.S. and Europe still trying to develop fusion. These are called Tokamaks. Princeton has one.

Some Present and Historical Considerations About Nuclear Energy

Relative Costs

The cheapest non-subsidized energy available to the U.S. is that charged by Quebec Hydro: about 7 cents per kWh. Figure 16-1 indicates that nuclear is reasonably competitive with natural gas and coal, but still substantially cheaper than solar energy.

Costs, Power Generation
2016 - Predicted



Source: EIA, Annual Energy Outlook, 2009
Note: Costs Quebec Hydro 6c per kW

Subsidies

Nuclear Power has benefited from large subsidies.

Subsidies per se are neither good nor bad. But they are most effective when they are explicit and transparent, not hidden. Subsidies to nuclear energy – whether now or in the past – could be a good or bad idea, depending on what the subsidies do. But from 1960 through at least 2013, the subsidies were largely hidden, consisting primarily of federally-imposed limits on liability for firms producing nuclear power, insulating them from much of the costs of any nuclear accident.

There are in fact good arguments for relying on nuclear energy – cheap, clean - in the sense that it results in low CO_2 emissions.

But there are two very significant externalities associated with large nuclear plants such as now used in U.S., Japan, and France (600 MW>).

1. Back End Externality – What to do about nuclear plant waste? Where to store something where radiation has a half-life of 250-500 years or, for some materials, even half a million years. Most states in the U.S. display a strong NIMBY attitude on this question (NOT IN My Backyard).
2. Middle of Nuclear Cycle – Power Generation Externality
   The nature of risk in nuclear energy.
   Nuclear energy is one of those rare examples of projects involving a very low probability of disastrous outcomes, but with a very high cost associated with the low probability event if it ever occurs. This kind of risk cannot yet be covered by private sector insurance – it can only be covered by something as large as a central government – able to pool risks.

Nuclear Energy has always had two kinds of subsidies in the U.S., Japan and elsewhere. Both subsidies have been largely concealed.

1. Least important are loan guarantees provided by governments to firms installing nuclear plants. These are large multi-billion $ projects. This means firms pay a lower interest rate on loans to build plants, which results in a subsidy to the firms.
2. Second and most important – Implicit and explicit insurance provided by governments to limit liability of operators of nuclear plants.

The Japanese Earthquake / Tsunami / Nuclear Accident is a very good example of a risk with a very very low probability of materializing, but with a very, very high impact if it does come about.

Do you understand these risks somewhat better now – after the Japan Earthquake – Tsunami – Nuclear Accident.

Just how large the U.S. insurance subsidy has been to U.S. nuclear power firms?

- The "fallout" from even one partial melt-down of a reactor could be tens of billions in liabilities. Consider the insurance premiums. Very high premiums are needed on a $10 billion policy to cover the risk of a nuclear accident.
- When the government limits liability of nuclear firms to, say, $50 million, this subsidy can be very large. But in the U.S., the subsidy was never known by public until about 1984.

Obituaries for nuclear power have been common especially since the Japanese earthquake and Tsunami in 2012. Some nations announced an end to reliance on nuclear power:

Germany	Announced in 2013 that it will shut down all nuclear plants after 2022
Italy	Voters overwhelmingly defeated plans for new nuclear capacity in a 2011 referendum
Japan	Put hold on new reactors after Fukushima
U.S.	Three new permits have been issued recently for new nuclear plants. It is not clear that they will ever be built. Maybe not. But not because of worries over nuclear accidents. Rather, because of prospects of really cheap natural gas for the next twenty years (shale gas). Cheap natural gas is the really big threat to nuclear power in most nations, including the U.S.

Nuclear Power in Emerging Nations

Some new reactors have a capacity as large as 1,700 megawatts.

- But, although nuclear obituaries are being written now in rich nations, many emerging nations have recently installed nuclear capacity and have plans for more.
- In 2010, there were 53 new reactors under construction worldwide.
- By 2011, only 1/8 of nuclear power plants were in emerging nations, mostly in China and India.
- Many emerging nations have explored nuclear power options. But few can afford the price tag for a typical nuclear power station. Typical Systems; These are usually large – 650 to 1000 megawatts of installed capacity – and costs run between $7 billion to $10 billion each.
- But there are 16 larger emerging nations that now have applications pending before the IAEA (International Atomic Energy Agency). These include Algeria, Chile, Egypt, Malaysia, Philippines, and Thailand.
- The likely future for nuclear power will involve some large nuclear power plants for the larger emerging nations. But elsewhere, the future for nuclear power in emerging nations may be in new reactor designs – modular designs that downsize nuclear power plants: for example, nuclear power plants the size of railroad cars. Most of these nuclear plants range between 125 megawatts to 140 megawatts, or about 1/8 the size of a typical 1000 MW reactors now in use in many nations. However, Westinghouse is developing a 335 MW reactor. These reactors are not only small, but some are portable, and of course the small plants are much more affordable to small emerging nations.
- Also if governments do subsidize the risks, the small reactors can produce affordable power. Why? While small reactors lose economies of scale, relative to 1,000 MW reactors, they involve much lower *capital* costs than the bigger plants. Also they have much shorter construction times.
- It is important to understand that up-front capital costs are the most significant in building regular size nuclear power plants.
- The regular size nuclear power plants are among the most capital-intense of all investments. Most of these capital costs are construction costs that extend over a decade involving immense volumes of concrete, piping, metal etc. These building costs are called “overnight” costs. For larger (e.g. 650 MW or more) nuclear power plants, the overnight costs account for up to 2/3 of the costs of supplying power.

And, overnight costs for regular size nuclear plants are double that for coal plants and four times that of natural gas-powered plants.
- Small modular reactors are also safer than larger plants. Why? They have fewer moving parts that can fail. Also, the nuclear reactors in the modular reactors operate at much lower temperatures than regular large reactors.
- Nuclear power in emerging nations should not be written off for good. To summarize, the new, modular reactors feature:

    1. Affordable capital costs – between $500 million and $750 million
    2. Affordable electric power – because of much lower capital costs, much shorter time of construction
    3. Safety – for reasons we discuss below
    4. Fewer Back End problems – waste storage and disposal (can store the smaller quantity of waste on site for 60 years at least)

Final Note on Nuclear

Some believe that if we ever have reasonable carbon taxes, nuclear will bloom. Before any country gets too enthusiastic about nuclear power, they need to consider further points that are almost never considered in decisions about building and operating nuclear power plants, especially typical 1,000 MW (or larger).

Decommissioning Costs

What to do with an old reactor that has outlived its useful life? There is a huge problem of disassembly and disposal of contaminated materials. Done correctly decommissioning would easily cost nearly $1 billion per plant.

So governments in 1960s, 70s, 80s, and 90s "kicked this car down the road," as governments are prone to do. In other words, they left this problem and the heavy costs to the next generation.

On that note it is appropriate that we close. Governments everywhere, when faced with looming economic threats, tend strongly to “kick the car down the road.” We have in very recent years seen this as governments everywhere (including the U.S.) have kicked the car down the road on

- Social security insolvency
- Climate change
- Water resources
- Growing budget deficit
- Growing government debts
- Government pension liabilities
- Failing education systems

The task for good economies is to try to make sure that the public is aware of the liabilities that are being placed on future generations, who have no voice in the matter at all.

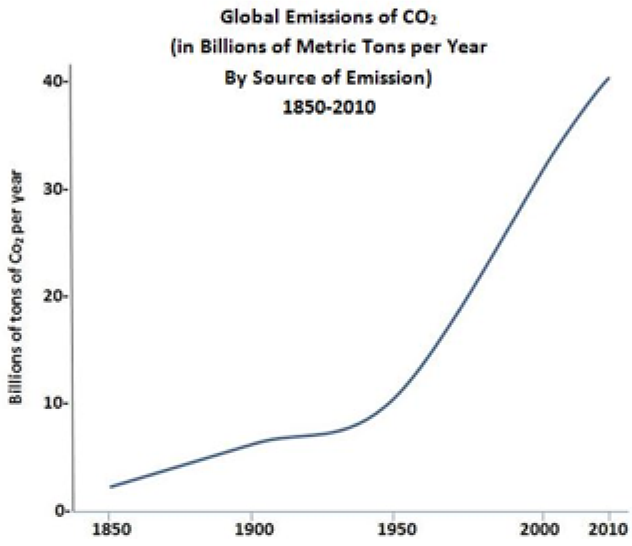
ENERGY: GLOBAL WARMING CHANGE

Introduction

Worldwide concern over the effects of “greenhouse” gases on climate change became increasingly evident in the late eighties and early nineties. International efforts to curb emissions of these gases culminated in the Kyoto Protocol Treaty, negotiated in 1997 in the City of Kyoto, Japan. The Treaty initially applied only to industrialized countries, and not to emerging nations. Although several industrial nations declined to sign the Treaty, it came into effect in February 2005. Perhaps the most notable refusal to agree to the Protocol and Treaty was the United States. There the Senate delivered a near unanimous vote against this accord, citing the lack of commitment of China, India, and other large emerging nations to reduce emissions.

Signatories to the Kyoto Treaty agreed to reduce the collective emissions of greenhouse gases of industrialized nations by 5.2% compared to 1990. It was expected at the time that this target would actually result in a 29% cut in emissions by the year 2010. The Treaty applied to overall emissions of six greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_{20}), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). However, in public discussions and in the press, the prime focus has been upon reducing emissions of CO_2 over time, even though the impact of the greenhouse gas methane, pound for pound, has more potent warming effects than CO_2. However, methane is far less abundant in the atmosphere than is CO_2. Still, this molecule may be responsible for as much as one-quarter of global warming. It is to be noted that some atmospheric methane arises from natural sources, such as gas seeps or wetlands.[footnote]
Eli Kintisch, “Hunting a Climate Fugitive”, *Science*, Vol. 344(6191), June 27, 2014.

If CO_2 emissions only are considered, it is apparent that this source of greenhouse gas has climbed precipitously since 1950, from about 10 billion tons per year to about 35 billion tons in 2012, per year a 3½ fold increase (see Table 18-1). Emissions of CO_2 continued to climb after 1997, as well as after 2005, when the Treaty came into force.



As indicated in Figure 17-1, the Treaty has not been effective in reducing CO_2 emissions.

The European Union moved early on after 2005 to curb global warming. In 2007, the EU agreed to a 20% reduction in greenhouse gas emissions. This was intended to set the stage for a very sharp reduction of 80% by 2050. The 2007 EU agreement resulted in little concrete progress, leading the EU nations to agree in 2014 among themselves (not by treaty) to take further measures intended to cut greenhouse gases emissions by 40% from levels obtained in 1990.

Shortly after the latest EU action, recognition of the inefficacy of the Kyoto Agreement led to a November 2014 groundbreaking agreement to reduce emissions by the two most important sources of CO_2 in the atmosphere: the United States and China. Together, these two nations accounted for 44% of global carbon emissions in 2013. This agreement calls for the U.S. to reduce emissions by 26% by 2025, and for China to begin to take steps to curb emissions by 2030, the first time China has agreed to any limits on emissions.

Perhaps by coincidence, and perhaps not, 2030 is the year in which total Chinese population is forecast to begin to decline, owing primarily to the “one-child” per family program initiated in the eighties and relaxed slightly in 2013.

In any case, several years will pass before the effectiveness of this latest accord can be expected to have any material effects upon global carbon emissions. Skepticism abounds, not only in the U.S., but in much of Europe as well. Criticism of the U.S.-China Accord has come from what could be called unexpected sources including Lord Browne, former CEO of British Petroleum. To quote: "The targets agreed by President Obama and President Xi will not be achieved with the policies in place. They will require new policies that could reduce the two countries oil demand by more than 17 billion barrels of oil over the next 15 years.[footnote]"
Pilita Clark, "Energy Groups Face Existential Climate Threat, Warns ex-BP Chief", *Financial Times*, November 19, 2014.

Skeptics, however, should bear in mind that international agreements to reduce damage to the atmosphere and climate are not by any means doomed to failure. A case in point is the Montreal Protocol, signed in that Canadian City in 1987. The purpose of this agreement was to reduce the atmospheric presence of ozone – depleting substances (ODSs) in the stratosphere especially hydrofluorocarbon (HCFC). These substances were adjudged by scientists to be responsible for very harmful depletion of the stratospheric ozone layer, especially in polar regions. There the "ozone hole" in the atmosphere was gaping above Antarctica, thereby depleting the ozone layer. Most of the ODSs are also potent greenhouse gases. The ozone layer is vitally important to humans, animals and plants because it protects life from ultraviolet (UV) radiation from space.

The U.S. and other larger industrialized nations before 1987 were the principal sources of emissions of ODSs. Virtually all emitting nations, including the U.S. were signatories to the Montreal Protocol. After more than a quarter century of experience, the Montreal Protocol may be adjudged successful. While the ozone layer remains in some danger because several ODSs remain in the atmosphere long after emissions end, and some HCFCs in some years (2007-08) have increased at rapid rates, the risks to the layer have been materially reduced by worldwide actions to control the global production and consumption of ODSs since 1997.

The majority of these substances have been phased out of production, while demand for substitutes for HCFCs such as perfluorocarbons (PFCs) has increased. This has helped protect the ozone layer, but some of these substances are potent greenhouse gases as well.

In any case, the Montreal Protocol and its amendments since 1997 have served to reduce ozone-depleting substances by about 10 billion metric tons by 2011. By comparison, global emissions of CO_2 exceeded 35 billion tons per year in 2014. The Montreal Protocol, even with its less-than-perfect results, stands as an example of what can be achieved when commitments to agreement on measures for atmospheric protection are firm and widespread.

Implications of Climate Change

Some doubt that global warming is underway. I believe otherwise. I have personally witnessed the gradual retreat, since 1995 of glaciers in the Northern Hemisphere (Alaska), the Southern Hemisphere, Patagonia (in Southern Chile) and in the high Andes of Peru. And there is abundant, well vetted evidence of global warming in Polar Regions, especially the Arctic, from Alaska to Greenland to Siberia and beyond. Indeed there are some indications that the Arctic is warming twice as fast as the rest of the world. [footnote] The subtropics have not been unaffected. Temperatures in Northern Kenya have become so hot during daytime that farming, school attendance and other daily undertakings have become a struggle for rural villagers. For example, students now attend classes from 6 to 9 PM and from dawn for two more hours, to avoid the heat of midday.
See for example, “The Melting North”, *The Economist*, June 16, 2012, pp.3-10.

While clearly, in some important regions, the earth has been warming, can we be certain about the causes? Human activity that generates greenhouse gases is surely a major part of the problem. How much is difficult to say, but it is clearly the view of most (not all) members of the relevant scientific communities that the prime cause is human activity.[footnote] This has been called the anthropogenic view of global warming.
This view is clearly stated in the Landmark Report of the Intergovernmental Panel on Climate Change (IPCC), “Summary for Policymakers, in Climate Change 2007, The Fourth Assessment Report.” See also Nicholas Stern

“The Economics of Climate Change: The Stern Review”, Cambridge University Press, 2007.

However, human activity has not been the only cause of global climate change. Major shifts in ocean current (such as the Gulf Stream or the Humboldt Current) could account for a portion, since the oceans are never in equilibrium.[footnote] But even more important may be changes in solar cycles, according to some studies. Certainly there have been interaction between solar phenomena and warming. One study has suggested that half the warming over the 20th century may be explained by solar changes.[footnote]
Ali Kilcik, “Regional Sun-climate Interaction”, *Journal of Atmospheric and Solar-Terrestrial Physics*, Vol. 67(16): 1573-79, November 2005.
N. Scafetta and B.J. West, “Phenomenological Solar Contribution to 1900-2000 Surface Global Warming”, *Geophysical Research Letters*, Vol. 33(5), March 2006.

Many predict looming calamity from global warming. In March 2012, two Australian climate scientists asserted that this is the last decade the world has to act before we pass the “tipping point” of 2 degree Celsius warming. This would be especially harmful for tropical, emerging nations. Warnings from other sources are even more dire. The MIT Joint Program on the Science and Policy Change forecasts that with no policy changes to curb emissions of greenhouse gases, global average surface temperatures could rise by as much as 5.2 degrees centigrade, bringing with it disaster. The MIT group also maintains that even if policy changes do succeed in limiting 21st century emissions to desired level, the median predicted warming level would be 2.3C.[footnote]
Mark Jaccard, “An Economist’s Journey”, *Science*, Vol. 343(6169), January 2014, pp.371-372.

There have been repeated warnings from the U.N. Some climate specialists believe that limiting emissions to 42 billion metric tons annually by 2030 and further limiting emissions to 22 billion tons by 2050, would allow the world to stay within the 2° centigrade “tipping point. The U.N. considers this limit to be ineffective in holding warming to 2° centigrade.[footnote] According to the U.N. Undersecretary for the Environment, “The time

window for reaching the 2° level is closing, closing, and the costs of getting to that goal is increasing, increasing".
United Nations Enviromental Program, The Emission Gap Report 2014.

Those who forecast catastrophe are essentially saying that unchecked, global warming could eventually lead to an environmental GOTTERDAMMERUNG, a word made prominent in Richard Wagner's last opera in his Ring Series in 1876. Gotterdammerung is a translation into German of an Old Norse phrase: Bagnarök, which in Norse mythology refers to a war between the gods that brings about the end of the world and its later renewal. Basically Gotterdammerung means when "all hell breaks loose".

Whatever the cause, global climate change has become a serious problem for the whole world, and the consensus is clearly that human activity is the leading cause.

Effects of Climate Change

The potential consequences for poorer nations look to be even more serious than for rich nations. It may widen income gaps between rich and poor nations because of the differential effects of higher temperatures. According to the World Bank, emerging nations will bear the brunt of the effects of climate change,[footnote] specifically that they would bear 75% to 80% of the costs of damages caused by changing climate.
World Bank, World Development Report: Development and Climate Change, Washington, DC: The World Bank, 2010, p.xiii.

Data for nearly 140 countries from 1950-2008 suggest that higher temperatures would have negative effects on growth in poor countries, but not so much rich ones. Estimates of effects vary. A recent National Bureau of Economic Research study[footnote] finds that a temperature increase of 1° Celsius would mean a decline in world per capita GDP or 8.5%. Still another recent study of emerging nations alone arrives at the much less pessimistic conclusion that a 1oC increase in surface temperature would lead to reductions of only 1% in per capita GDP.[footnote] Finally, the World Bank estimates that even with 2°C warming, the minimum the world is likely to expect, could result in permanent reduction in GDP for Africa and South Asia.[footnote] How might high temperatures reduce growth rate in poorer nations?

Dell M., Jones B.F., Olken B.A. 2008. *Climate Shocks and Economic Growth: Evidence from the Last Half Century.* National Bureau of Economic Research Working Paper 14132. Available at www.nber.org/papers/w14132.

“The Weather Report”, *The Economist*, January 18, 2014, p.76.

World Bank, op.cit. pp.XX.

1. Lower crop yields in the tropics, but likely not in temperate zones.
2. Resurgence of tropical diseases and Northern migration such as malaria and yellow fever.
3. Sea level rise flooding Bangladesh, Maldives, parts of Coasts of India, Thailand, and other low lying areas.

It is, however, apparent that there is wide variation in estimates of just how much rising CO_2 or other greenhouse gases will warm the earth. Claims of precision in these estimates merit some skepticism. It is also unclear what the net worldwide effects of climate change might be over the next 100 or 200 years, on agriculture, disease or drinking water.

Moreover, there are respected climate economists who, while they do not doubt that global warming is very likely occurring, are skeptical that efforts to curb greenhouse gas emissions will, on balance, benefit humankind. Economists such as William Nordhaus have argued for years that the near term economic growth benefits from burning fossil fuels outweigh the future estimated costs of climate change.[footnote] Nordhaus arrives at this conclusion by noting that typical studies of effects of future climate change value future costs and benefits equally with present costs and benefits (i.e. they use a near-zero discount rate to value future costs and benefits). Nordhaus, and most other economists, argue that future costs and benefits should be discounted when compared across several years, or even decades and especially centuries. This is because economic growth means that future generations will be wealthier, enabling the latter to better cope with climate change in their lifetime. But the much celebrated Stern Review of climate change (see footnote #4) does use a discount rate of near zero. (See

the Appendix to this Chapter for a review of cost-benefit analysis and discounting).
William Nordhaus, *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World*, New Haven, CT: Yale University Press, 2013.

The author’s view is that, on balance, the result of warming, realistic discounting of future costs and benefits or not, will not be positive for most of humanity, especially in the tropics.

If that turns out to be correct, then we must ask what can be done to reduce threats from climate change. We have heard from the doomsayers (catastrophe looms) and soothsayers (no climate change is occurring). What are doomslayers, those who seek sensible answers to difficult societal questions, to do?

Strong language has been used to portray a state of “immediate emergency” from the threat from global warming. But perhaps we should be also concerned about the threat of global cooling? This is a most unconventional statement. Nevertheless, further proliferation of nuclear weapons in Iran, North Korea and elsewhere could mean that today’s university students might possibly face in their lifetime a greater possibility of serious global cooling then of global warming. Why? A nuclear exchange of multiple megaton weapons in one or more regions could easily lead to nuclear winter for the entire world, lasting decades or even centuries. As of 2014, prospects for limiting the spread of nuclear weapons are not bright.

Still, climate change and other pressing environmental issues cannot be ignored especially, since emerging nations are forecast to bear the brunt of costs of warmer climate. Since there are no panaceas, a portfolio of policies must be deployed. Herewith is presented a portfolio with five basic elements, some applying worldwide, some more specific to the U.S., Europe and Japan. Other chapters in this book indicate the portfolio, while focusing on climate change, has spillover beneficial effects as well on deforestation, biodiversity, water pollution and water wastage. It should be noted that the remedies presented are primarily price based, which should be expected from an economist. However, the last two elements in the portfolio would not be viewed as price-based.

1. Curtail Deforestation Especially Tropical Deforestation

Over the years 1975-2010, the largest source of CO_2 emissions after China and the U.S. has come from Brazil and Indonesia, owing to annual deforestation of wide swaths of their tropical forests. Forests annually absorb millions of tons of CO_2 through photosynthesis. As we noted earlier, forest destruction, and in particular burning of forests is responsible for 20% of Global Carbon emissions annually. Higher taxes and royalties on timber harvests, reforms on property rights, plus removal of all subsidies for forest clearing and for ethanol from palm oil would contribute materially to curtailing buildup of greenhouse gasses, and contribute to other economic and environmental goals as well.

2. Drastically Curtail All Subsidies for Consumption of Fossil Fuels (and Ethanol from Corn) Worldwide

We have previously discussed energy subsidies at length, and their impact on income distribution (very pro-rich) and resource allocation (economic waste). In 2012, a dozen nations accounted for 75% of the worlds subsidies on oil, gas and diesel fuel. All but one are emerging nations. Iran tops the list at \$82 billion. Saudi Arabia was next at \$81 billion, then Russia, China and India. Each of these spent \$60 billion on the subsidy. Other major energy subsidizers: Venezuela, Egypt, Mexico and Algeria, and until late 2014, Indonesia.

In addition, mindless U.S. subsidies to 120 plants producing ethanol from corn are as reckless and pernicious as any subsidy anywhere. The policy has been clearly misguided. Scientists in 2007 warned of the danger of failure of the Federal Corn for Ethanol policy as an anti-global warming tool. Too many Midwest farmers plowed over virgin land to plant more corn. Since 2007, 6.7 million acres of grassland and conservation land has been lost since the federal government required that gasoline be blended with ethanol. How big is 6.7 million acres? Larger than Yellowstone Park, Everglades Park and Yosemite Park all combined. Further, 1700 gallons of increasingly precious fresh water is required for the corn needed for each gallon of ethanol. Plowing virgin grasslands to get more acreage for corn releases CO_2 locked into the soil. Making matters worse, the corn farmers have used increasing volumes of fertilizer, especially nitrogen and other chemicals, that eventually end up in rivers in the region and ultimately, the Gulf of Mexico.

Excess nitrogen and other chemicals leak into watersheds. Massive applications of fertilizer for corn in the Midwest have vastly enlarged the “dead zone” in the Gulf of Mexico – an 8,000 sq. mile area where nothing can survive. As of 2009, 30% of the nation’s corn crop was used to make ethanol that amounted to 8% of U.S. gasoline supplies. Just in order to replace 10% of U.S. gas and diesel consumption, the U.S. would need to convert 40% of cropland to ethanol.

3. Enact New and/or Increase Existing Carbon Taxes

Existing taxes can be increased to provide further market-based incentives to curtail growth of CO_2 emissions. In any dynamic strategy, such taxes are best linked to actual global warming. Once the relationship between atmospheric CO_2 and global warming is more closely established, carbon emissions taxes could be made rise by $4 to $20 per decade, depending on need.

Taxes on gasoline and diesel fuel taxes are obvious forms of carbon taxation. Consider the experience in developed nations.

U.K.	$3.75
Czech	$2.70
Germany	$2.60

Sweden	$2.53} $\bar{x}$ = $2.53
Netherlands	$2.34
Italy	$2.34
France	$2.33
Austria	$1.97
U.S.	Federal 28 Cents per gallon States (varies: 10 cents – 30 cents)

Motor Fuel Taxes (U.S. $ per Gallon) (2012)

The average tax in the developed nations listed above was $2.53 per gallon, compared to a U.S. federal tax of only 28 cents and 38 cents in some states and 48 cents in others. European rates are about 4 times higher than in the U.S. and 10 times higher than Venezuelan rates.

The combined U.S. taxes, averaging some 65 cents per gallon, do not begin to cover the costs of maintenance and repair of roads. U.S. vehicle fuel taxes are well below the marginal cost of road use, a clear violation of the economist’s condition for efficiency in resource allocation. The resulting costs of wear and tear on roads can be very high. In any case, the U.S. could contribute notably to efforts to reduce global warming simply by raising gasoline and diesel fuel taxes high enough just to cover the cost of road and highway use by vehicles.

4. Cap and Trade Systems

Cap and Trade systems attempt to place a price on global emissions of carbon, a major contributor to global warming. Ideally, such systems work in the following fashion:

A cap and trade system imposes strict quantitative limits (caps) on emissions from industry or agriculture. Then permits are granted for emissions. A market is created wherein the permits can be sold by those who emit less, and purchased by those who emit more. How is this done? The sequence for implementing a system is as follows:

a. Government first establishes a limit on the amount of CO_2 released by industry;
b. Then, governments issue a fixed number of emission permits;
c. Ideally, these permits are then auctioned (or given away) by the governments; and
d. Firms are allowed to sell excess permits that they do not need.

This system, it is hoped, will allow market forces to then distribute and price emission allowances. As the caps decrease year by year, the permits become more valuable (unless the government increases them). Firms producing products that led to CO_2 emissions bid for these in the market. The price goes up. Emissions of CO_2 become increasingly more expensive. So firms are given incentives to reduce emissions, either through new technological innovations, or cut-backs in the production that causes emissions.

One or another form of Cap and Trade systems has already been introduced in the EU, the U.S. State of California, and China. The European Cap and Trade system has, to date, been executed poorly. There, the carbon trade market is grossly oversupplied because the EU gave away too many credits. By November 2014, carbon permits traded for less than $8.00 per metric ton, and Europe was in that year burning more coal than before the Kyoto agreement of 1997. This experience does not at all mean we should ignore Cap and Trade as a tool. It means that the European mistakes must be avoided.

China recently adopted a timid form of Cap and Trade. The Californian plan, created in 2012, is more ambitious. Any business that emits more than 25 thousand tons of CO_2 per year must obtain permits from the state government for those emissions. Most of the permits thus far have been issued free of charge. An auction system was devised to distribute the remainder. From 2012-2014 there have been eight auctions. In the latest, in

August 2014, businesses paid $11.50 per ton for permits. A total of $2.27 billion had been raised from the auctions by Fall 2014.

The program has clearly been successful in raising revenues for the state. Whether the program helps to materially reduce emissions has yet to be determined. If the program does work as intended it would have reduced greenhouse gases arising in California by 2% by the end of 2014. Should the program prove successful, it may become a model for other states, or even the national government.

5. Encourage Worldwide Shifts from Coal-fired Power Plants to Natural-gas Fired Plants

A typical coal plant burns 10 million BTUs (British Thermal Units) to produce one MWh (megawatt hour) of electricity, but an efficient natural gas power plant burns only 7 million BTUs to get one MWh of electricity. That is a 30% reduction in fuel needed, and the natural gas yields as much as 50% lower carbon emissions. In addition, construction of gas-fired plants is cheap relative to that for coal. Gas-fired plants cost only $1 million per MWh to build. So a 650 MWh plant costs $650 million. But a new coal-fired plant costs $3 million per MWh to build, or triple that for a gas plant.

That is a 30% reduction in fuel, and the natural gas yields as much as 50% lower carbon emissions. In addition construction gas-fired plants is cheap relative to those for coal. Gas-fired plants cost to build only $1 million per M.W. hours. So a 650 M.W. plant costs $650 million. But a new coal-fired plant costs $3 million per M.W. hour to build, or triple that for a gas plant.

6. Invest in Programs to Make Low Carbon Energy Cheaper

For the short to medium-term, the whole world could carefully consider the example of France which relies heavily on nuclear with relatively few problems. If the U.S. is serious about reducing carbon emissions, nuclear energy requires a sober, new look. However, because of very high capital costs and long construction periods, new nuclear capacity is not competitive without a carbon tax of at least $20 per ton, especially when natural gas is as low as $2.00 or $3.00 per million per BTU.

Developed and emerging nations are also beginning to capitalize on opportunities in such non-traditional energy sources including wind, solar, and tidal power, to ultimately bring their combined share of energy to at least 15% by 2025. Technologies in all three, especially wind, are finally beginning to mature, and the costs of deployment are falling.

Sensible investment in bio-fuels, including bio-diesel produced by algae and even bio-fuel from sugar and plant waste could contribute to reduction in emissions as long as it is recognized that the U.S. program for ethanol from corn is not a sensible answer to any question (except the Iowa caucus in Presidential election years). This is one of the most ill conceived subsidy programs ever. Not only does it not, on balance, provide any significant incremental energy, it greatly pollutes the soil and the ocean.

Appendix Chapter 17: Project Evaluation and Sustainability

This appendix reviews concepts on discount rates, Net Present Value (NPV), and Internal Rate of Return (IRR). Note that the terms project appraisal, project evaluation, and cost-benefit analysis are used interchangeably.

Private Sector Project Evaluation----Uses market information

1. $\text{NPV} = -K_o + \frac{R_1 - C_1}{1+r} + \frac{R_2 - C_2}{(1+r)^2} + \ldots + \frac{R_n - C_n}{(1+r)^n}$

Where:

K_o = Initial Capital Costs (Front End Loaded Capital Costs)
R = Revenues accruing to a private firm
C = Costs to the firm

This is all market information.
NOTE: For years 1 through n, costs include any capital expenditures in

addition to K_o, but not depreciation.

r = Opportunity cost of capital to firm (the discount rate)

Government Investments
For government, public investments in projects and any multi-year programs such as those intended to curtail CO_2 emissions:

$$2.\ \mathrm{NPV}_G = -K_o + \frac{B*_1 - C*_1}{1+i} + \frac{B*_2 - C*_2}{(1+r)^2} + \ldots + \frac{B*_n - C*_n}{(1+r)^n}$$

Where:

B* = Measured benefits ($, lives saved, floods prevented, etc.)
C* = ($, plus any costs due to externalities)
i = Social discount rate when [o<*i*<r]
Social rate less then private rate. To be explained.

The Stern Review cited in this chapter utilizes the NPV framework to forecast the future net costs of global warming. Example:

$$\mathrm{NPV}_{\mathrm{wm}} = -K_o + \frac{B_1 - C*_1}{1+i} + \frac{B_2 - C*_2}{(1+r)^2} + \ldots + \frac{B_n - C*_n}{(1+r)^n}$$

Where:

B_1, B_2, B_3 = Benefits are assumed to be negligible or middling, depending on the decade
C* = Costs of global warming to society worldwide (costs alternate on sea-level rise, temperature changes, presumed higher level incidence of tropical diseases (dengue fever, malaria, etc.)

It is to be noted that the Stern Review uses a very low rate of social discount (0.01%) and with a low discount rate, costs emerging decades from now are unduly magnified. And, the really big costs do not emerge for decades.

Major point: Stern uses a social discount rate of 0.01%.

NATURAL CAPITAL: WATER

Water

We begin this Chapter with the disturbing statement that world supplies of fresh water are in jeopardy, not only in the U.S., but in China, India and other large economies. Water is becoming the most abused natural resource. The threat to fresh water is of two types:

Quantity

Diminishing quantities from underground aquifers, owing to growing depletion arising from both industrialization and population growth: The 2014 London World Water Summit projected that world water consumption will double between 2014 and 2025.

Widespread contamination and pollution of all water on the planet, only 1.5 percent constitutes fresh water. 97 percent is saltwater in oceans. Water usage is heavily concentrated in agriculture. 93 percent of water consumption occurs in agriculture, mainly for irrigation. (Note: the figures are for water consumed, or water that becomes unavailable for other uses).

Of total water consumption, only 7% is for household and industrial use.

Quality

Sanitation challenges affecting water resources continue to mount. To illustrate, contaminated water worldwide is a leading cause of infant mortality from diarrhea and related gastric problems (2 million children a year die). Contaminated water in many areas has led to widespread cancers of the digestive tract.

North America	17,400
South America	38,300
Europe	4,240
Africa	5,720
Asia	3,920
Australia and Oceania	83,600

Some Worldwide Water Data
Potential Water Availability Worldwide (cubic meters)* 2010*Measures the amount of water left over after utilization by the population of each region.

Eastern U.S.	1,000 - 2,000
Western U.S.	250 - 5,000
Amazonian Rain Forest (Brazil, Colombia, Peru)	2,000 - 3,000β
Northern Chile	<250
Sahara	<250
Indonesia	2,000 - 3,000
S.E. Asia	1,000 - 3,000
South China	1,000 - 2,000

North China	250 - 300

Total Annual Rainfall in Millimeters per Year

This experience of China is illustrative concerning problems both water of availability and water quality. Water is relatively plentiful in South China; but very scarce in North China (see Table 18-2). And chemical water pollution as we will see is widespread (if we considered also bacterial pollutants, the problems are even worse).

Chinese rivers are disappearing. In the 1990s, China had 50,000 rivers with catchment areas of over 100 square km or more. Now, the numbers of such rivers is down to 23,000: 27,000 rivers have disappeared as rivers in 60 years.

Moreover, 80% of the rivers flowing through China are heavily polluted. Even worse, research reported in the November 11, 2011 issue of Science shows that fully 90% of Chinese shallow groundwater is polluted. 37% of this water is so polluted that it cannot even be treated for use as drinking water. The costs to China yearly from water pollution issues are estimated at 2.3% of GDP. And 70% of Chinese get their drinking water from underground.

In many villages in China, water from contaminated rivers or groundwater is the only source of water available. Every year about 190 million Chinese (15% of the population) become ill from bad water. Every year 60,000 Chinese die because of water pollution. This has happened for two main reasons:

- In China’s very rapid economic growth experience after 1990 environmental issues were decidedly secondary – incentives were to maximize output, even at heavy costs to air and water quality.
- China does not have laws on groundwater contamination. This is a striking example of the importance of institutions in economic development.

Quantity Issues

Chinese freshwater resources are estimated at 2,200 cubic meters (m^3) per person. Note: the world average for freshwater resource is 8,800 m^3 per person. So China is already on ¼ the world average. And the Chinese number is still falling.

The northern Aquifers are being sucked dry, a particularly serious issue in the North China Plain (NCP).

Over the past four decades acquifers of the North China Plain (NCP) has been nearly sucked dry; over 120 billion m^3 has been pumped from the land. This is much more water than has been replaced by rainfall in the region.

The NCP had only 1800 powered wells in the 1960s. But, just by the year 2000, the NCP had 700,000 such wells, an increase of about 4000%.

Also the Chinese government announced in 2011 a new initiative to prevent and treat groundwater contamination, at a total cost of $5.5 billion over 10 years. Yet $5.5 billion is merely a beginning.

But no remedial programs are yet in force to remedy river pollution. Some estimates are that river cleanup would cost $50 billion over 10 years in China.

Finally, in 2014 the Chinese Government was close to completing a huge water engineering project. This is the South-North Water Diversion project, the largest such project in modern history. The idea of this project is traceable at least to 1952, when Mao Zedong suggested that the parched North could “borrow” water from the relatively water-rich South.[footnote] The North has only 20% of China’s naturally available fresh water, but fully two-thirds of the farmland. And in such Northern cities as Beijing, each resident has available only 145 cubic meters of fresh water per person per year. Compare this to the World Bank’s definition of water scarcity: 1,000 cubic meters per year. The new waterway will, however, supply only 33% of Beijing’s annual needs. The vast waterway extends from the Yangtze River in the South all the way to Beijing, a distance of about 750 miles, at a cost of more than $62 billion, not including construction and operation of 13 new water treatment plants to clean the water.[footnote]

The project involved first a deepening of the 1,400 year old "Grand Canal", which carries nearly 15 billion cubic
The Economist, Ibid. p.44.

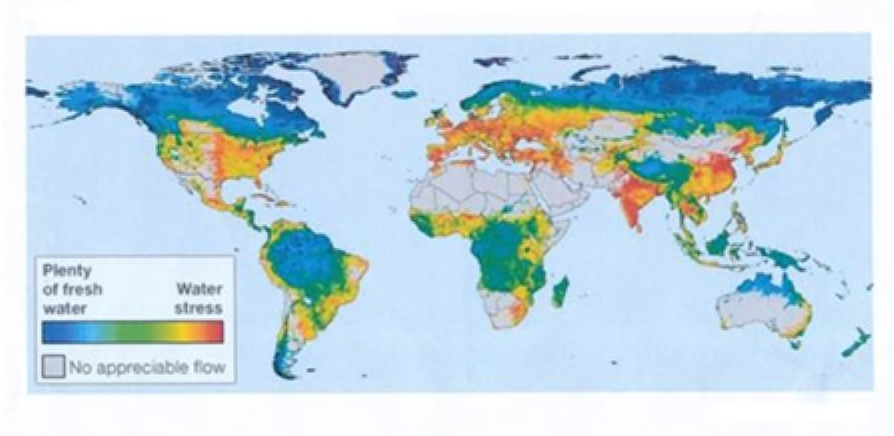
Authorities hope that the new waterway will help solve China's water crisis, which costs the country more than 2% of GDP, according to the World Bank. Could this expensive project prove to be only a temporary palliative? Yes, unless China begins to change the way it prices water. Low prices have led to wholesale water waste including the construction of dozens of extremely water-intensive golf courses around Beijing. Sharply underpriced water in North China is used for agriculture, which accounts for 70% of water used in the region. And, as we will see later in this Chapter, water for household in China costs about a tenth of what it costs in Germany.

China is not alone in its water problems. An article in Science, August 5, 2011 claims that 1/3 of the world's population now lives in water stressed conditions. This proportion will grow, over the coming decades, as some of the most important sources of freshwater are in decline largely due to climate change.

A World Bank report on climate change in 2011 maintains that 68% of the freshwater resources of the world comes from glaciers. While the author is somewhat skeptical at this statement, he has personally observed Glaciers melting rapidly over the last two decades in Alaska, Chile, Peru and the Himalayas. This has further endangered water supply especially in Peru, India and Pakistan for certain.

The Global Picture

Consider Figure 1, which shows water stress around the world. Note that stress is high in parts of the U.S. (the Plains, Florida, Texas), in Europe especially in southern half of Australia, not to mention the Sahara. Also, stress is very high in India, Pakistan, Mexico and China. The costs of reducing global water stress will be very high between $7 trillion and $10 trillion. The costs will include expenses of building dams, canals, aqueducts and pipelines, and above all increased conservation of scarce water, primarily through higher prices charged for water, especially in agriculture.



Natural Profile of Water Stress

Source: *Nature*, 2010

It is very important that we understand that global water issues are not separable from energy issues, from global warming problems, or from fisheries issues.

Growing concerns about fresh water are beginning to shape serious discussion of energy use. There are only small water requirements with solar or wind energy, but there are very large water requirements in coal and in shale, oil and gas extraction and especially nuclear power generation, where steam is made to turn turbines. Nuclear power plants require much more water to produce a kilowatt hour of power, relative to other forms of steam generation such as coal. In an earlier module we cited the immense amounts of water required to frack each well, and noted that the single factor most likely to limit fracturing worldwide is probably lack of water, especially in nations with the largest shale deposits, including China and Mexico. In the U.S., the electric power industry now accounts for about half of all water withdrawals.

Water: Sustainable and Unsustainable Use

Earlier, it was stated that according to the U.N. the minimum amount of water a person requires for drinking, hygiene and growing food is 1,000 m^3 per year. This is about 2/5 the size of an Olympic size swimming pool.

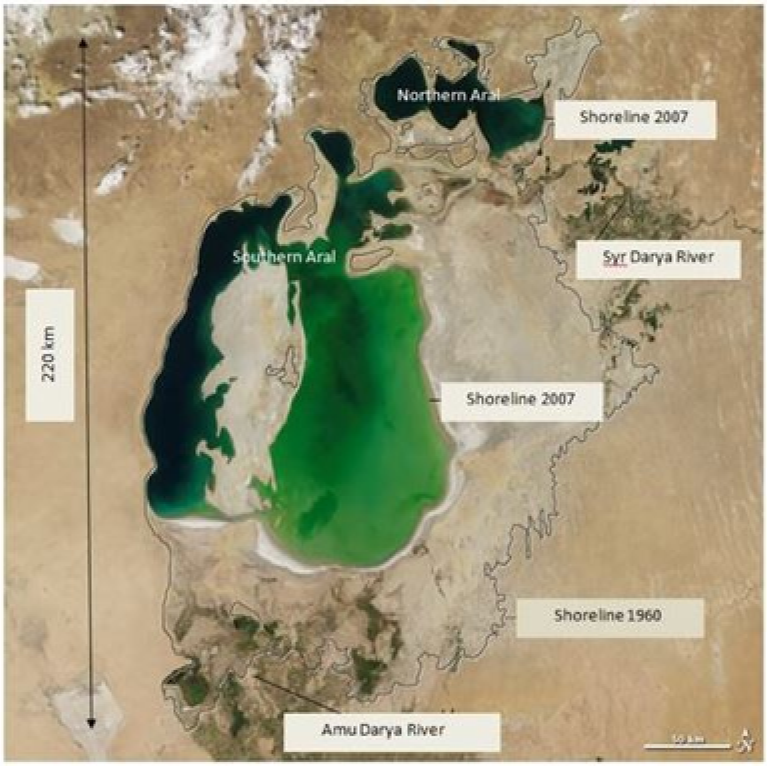
We have seen that dozens of nations already face serious water shortages; several others are steadily moving from chronic to acute water problem.

Acute Hot Spots	**Chronic**
Mexico City, Pakistan	North China
Lima	Peruvian Andes (glaciers)
Northern India	Madagascar
S. California	S. Spain
Central S. Florida	South Africa
Australia	
Syria	

The Himalayas in Northern India are where three of the world's greatest rivers rise, all within a 100 km area: the Ganges, Indus and Brahmaputra rivers. Absent major changes in patterns of water use, the day may soon arrive when the Ganges, worshipped by 800 million people, becomes an annual, not a perennial river.

However, all of India is short of water (220 million Indians lack safe drinking water). An examination of India's water use in the last 50 years is instructive. In 1960, the water table in many parts of India was only 7 to 8 feet deep. Then, a farmer could sink a very shallow well to obtain water. By 2013, in the same places a farmer must go down 100 to 200 feet or more to find water.

The Aral Sea: Perverse Consequences of a Zero Price for Water
1961-2011



Horror Stories on Water Conservation

Perhaps the most infamous case of grossly misguided water management has been the Aral Sea in Kazakhstan and Uzbekistan. In 1960, when these countries were part of the former Soviet Union, the Soviet Government in Moscow decided to divert water from two rivers: the Syr Darya and the Amu Darya to irrigate new cotton fields in Turkmenistan and Uzbekistan. Both rivers fed the Aral Sea, then a huge freshwater lake. By the 1970s, the Amu Darya no longer reached the Aral Sea. By 2005, the volume of the sea dropped by more than 80%, and the sea level fell by about 56 feet (18 meters). By 2000, there were in effect two Aral Seas: a large saline area in the south and a smaller less saline area in the north. Together, both seas were but 30% of the original.

The prime cause: the central planners in Moscow placed a zero price on the diverted water used for irrigation of cotton, a very water-thirsty crop.

Now, in what remains of Aral Sea there are virtually no fish; the sea is too saline for almost any life. This is a very good example of the type of bungling that came from Soviet central planning.

Another infamous case has been the California Central Valley. This valley runs from Bakersfield to Stockton to Red Bluff. The valley is 5/8 the length of California. This area now faces looming serious water shortages. Here again, water was wasted through decades of artificially lower prices. Cheap water allowed farmers to grow very water dependent crops, especially cotton. After many years, Californians began to respond to a steadily deteriorating situation: five new measures emerged to promote water conservation in California, all of which might be considered in emerging nations as well.

First, to encourage water conservation by farmers, heavy water wasting sprinklers were, and are being replaced by microsprinklers and drip irrigation. Second, farmers are leaving more fields fallow. Third, higher rates are being charged on water usage: in 2009 rates were increased by 15%. Fourth, market-oriented “water banks” have been proposed. This comes from the older idea (1950-60s) of soil banks to conserve soils.

In the soil banks, the government paid farmers to take land out of cultivation. In the water banks, the state government pays the farmer to take, say, 100 acres out of cultivation. The state provides $2.75 per acre-foot of water (326,000). The farmer receives $90,000 not to use water on the 100 acres withdrawn from cultivation.

Another very different measure to conserve water may be more significant in the future: Desalination plants. Given that more than 97% of the world’s water is salty successful desalination would vastly expand world water supplies. There were in 2013 75 major desal projects in process worldwide. These projects cost an average of about $350 million each. Desal plants are being built in San Diego, Australia, Spain, Britain, India and Portugal, among other nations. A very long-horizon outlook is needed to decide to build a desalination plant. Traditional groundwater sources cost about 5 cents/m^3. For desal, even the cheapest was 40 cents/m^3 in 2013. This is 8 times the cost of securing groundwater supplies.

One of the most important ways to conserve water is improving maintenance and operation of water-delivery systems. Such measures include:

1. *Improving irrigation efficiency.*
   Irrigation canals constantly hemorrhage water through their beds. Much of this is unavoidable. However, some of this water can be saved by steps to increase irrigation efficiency. Such measures include drop irrigation, and avoidance of water thirsty crops such as cotton.
2. *Metering*
   When possible, water meters should be used to charge for water used. In Panama installation of meters reduced residential water use by 22%. Metering is not possible everywhere primarily for administrative reasons, but could become especially important in India, as we will see.
3. *Maintaining water pipes*
   Maintaining water pipes that deliver water helps curb or stop ubiquitous leaks of massive amounts of water, such as experienced in New York City and Delhi.

   Needless water wastage from this source is common the world over. In the U.S., 18% of drinking water is lost through leaks in water systems and water main breaks. In some cities in Pakistan 60% of water supplies are wasted due to leakages and/or theft.

   Water leaks are not inevitable. Consider Singapore: Singapore must conserve water. It imports almost all water through a pipeline from Malaysia. The city-state has taken vigorous measures to conserve water. Notably Singapore loses only 3% of its water to leaks, because the city-state faces a very strong incentive to avoid water waste.

India, Pakistan and Syria: Critical Issues

India’s water problems have been exacerbated by several factors, including effects of climate change especially the effects of melting of Himalayan glaciers that feed the Ganges, Indus and Brahmaputra rivers. This is clearly occurring, although the United Nations overstated melting in 2011. However, much of recent glacial melting in India is not due to CO2 effects, but due to “brown clouds,” or (soot from smokestacks).

Water has also been wasted owing to at least five further factors:

1. Deep underpricing of water usage. In big cities, pricing policies of government water boards covers only 40% of costs. For example, water is so underpriced in Delhi that citizens use 220 liters per person per day: twice that of much wealthier Paris
2. Deep underpricing of electricity to run water pumps contributes to water overuse
3. X-inefficiency or failure to minimize costs in SOEs responsible for water supplies is also a factor. Water in India is provided by Government Irrigation Departments. These departments are also deeply underfunded, understaffed and corrupt. The result has been very poor maintenance of water systems. Leakages are large. A water leak just ¼ in diameter results in losses of 15,000 gallons per day. At higher water prices, there would be a much greater incentive to fix leaks
4. Siltation of reservoirs from dams built to hold water contribute to the problem. Recall the discussion of deforestation and siltation in the module on forestry. Each year India loses to siltation about 2/3 of any new water storage capacity it builds
5. Misdirected planning. Between 1992 and 2004, India built 200 large and medium size irrigation projects. Nevertheless, the area under irrigation eventually shrunk by 3.2 million hectares (about 6.5 million acres)

India is not only depleting its rain-fed fresh river water, it is rapidly depleting its ground water. Groundwater in India used to be a renewable resource with sizeable aquifers and springs. But by 2011 so much had been pumped up and used for irrigation that 2/3 of India's groundwater was endangered.

The Indian experience in water utilization and water waste has been replicated in much of the rest of the world, so that in many nations, water has been so abused that it is not now a renewable resource.

Pakistan

Water availability is becoming a particularly serious issue in very arid nations. Pakistan is one of the world’s most arid countries. Average annual rainfall is less than 240 mm (compared to 2000-3000 mm in Indonesia).

Total availability of water in Pakistan has dropped from 5,000 M3 per person per year in 1950s to about 1,100 m^3 per person in 2010. Note again that the U.N. threshold for a region to be labeled “water-scarce” is 1,000 m^3 per person.

Forty percent of Pakistan’s population lacks access to safe water. Some believe that shortage of water is an existential threat to Pakistan.

Pakistan has severe water scarcity even though its watershed is fed by the Indus river, one of the three great rivers flowing through South Asia (the others being the Brahmaputra and Ganges). As earlier noted these rivers all have headwaters in a relatively small area of the Himalayas, where glaciers are melting. Flows in these three rivers could fall by 30-40% in the long run, a terrifying disaster for India, Pakistan and Bangladesh.

Siltation of rivers in Pakistan became very serious by 2012. In the U.S. and Australia, there are many dam catchments that can hold 900 days of water. By comparison, Pakistan–partly because of siltation–can store only 30 days' worth of water in the Indus Basin.

The situation does not have to be this precarious.

As has been the case for India, a large part of Pakistan’s problem has been water wastage in rural areas especially in agriculture. And in some cities, 60% of water supplies are wasted – leaked or stolen.

A big reason has been a near zero price of water.

A good beginning for a solution to Pakistan’s water problems would involve at least 5 steps:

1. Increase the price of water, especially irrigation water
2. Repair old canal systems
3. End electricity subsidies that encourage water-intrusive activity

4. Build, where feasible, a few medium-sized dams to store more water
5. Control leaks and stolen water

The most important measure for the shorter term is to end the deep underpricing of water. But this is not a panacea. It has to be part of the solution, part of a portfolio of solutions.

Underpricing of water resources has long been common all over the world not just India and Pakistan (see Table 18-3). It is safe to say where one finds acute crisis in water availability, heavy subsidies for water use are usually the prime suspect, except for regions that have experienced extended drought.

Finally, we note that Syria had one of the lowest use of water per capita, even before the eruption of civil war in 2011. By then, all renewable sources of drinking water in Damascus by then had been exhausted. Entire villages were vacated because of lack of drinking water. Conditions during the Civil War could only be worse.

Copenhagen	$7.38	Cape Town	$1.15
Perth	$6.59	Miami	$1.15
Atlanta	$6.30	Lagos	$0.94
Berlin	$6.30	Mexico	$0.94
Amsterdam	$5.29	Shanghai	$0.45
London	$3.80	Nairobi	$0.45
New York	$3.27	Delhi	$0.24

Los Angeles	$2.80	Nairobi	$0.45
Tokyo	$2.11	Delhi	$0.24
Rio de Janeiro	v2.14	Hanoi	$0.19
Bogota	$2.09	Cairo	$0.10
Chicago	$1.46	Dublin	$0.00

Prices of Water (U.S. dollars per cubic meter) in Selected Cities – Households (2013)Source: “What is Water Worth”, *Fortune*, May 9, 2014, p.96.

Table 18-3 displays the very wide difference in water prices for households. Clearly the lowest prices are found in emerging nations. Among emerging nations only those for Brazil and Colombia were above $2.00 per m^3. Water prices in Cairo in 2013 were less than 2% of that for Denmark. Note the very low price in oil-exporting Nigeria, where consumption of fossil fuels is also heavily subsidized. Prices in water-needy Delhi were but 4% of that charged by Atlanta. For rich nations such as the U.S., water prices vary by region: high in Atlanta and very low in Miami. Of the cities in the table, only Dublin in Ireland charged a zero price for water in 2013.

Water issues are truly critical for the world’s poorest nations. Both in urban and rural areas, access to clean water was, by 2006, not available to large proportions of the population. In urban areas, there are a dozen countries where access to clean water is available to only 75% of the people. These include Angola, Somalia, Nigeria, Yemen, and Haiti. In rural areas the problem is even worse. These are nine nations where clean water is available to less than 1/3 of the people (Somalia, Mozambique, Nigeria). Little wonder 2 million children and millions of adults a year die from water-borne diseases.

Earlier we noted that only 2% of earth’s water is freshwater, but 70% of that is frozen in glaciers and ice caps. So, animals, humans and plants have about 0.75% of total water to live on and most of this is underground, in aquifers or similar formations. The rest is falling as rain, sitting in lakes or reservoirs or flowing in rivers.

There has been a water crisis developing for decades. Why was so little attention paid to it until very recently? Because so much has changed.

As late as 1950, the world’s population was only 2.5 billion. Concerns over water supplies then affected far fewer people.

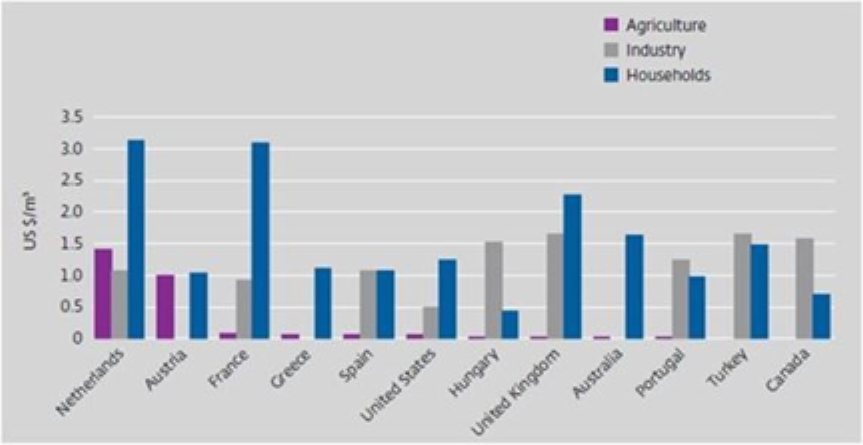
Then in the past 60 years, the world experienced:

- The Green Revolution, an inspired combination of hybrid seeds and fertilizers that also involved more water utilization for new varieties
- Population growth that increased the number of people on the earth to 7 billion by 2010, and should reach 9 billion by 2050 even though fertility rates are falling worldwide (except in the Middle East)

As a result, the amount of land under irrigation has doubled in 60 years but the amount of water drawn for agriculture has tripled.

We have seen that a wide variety of developed and developing nations have deeply underpriced household water. Water for agricultural use is also priced well below that for household and industrial use, as is evident in Figure 18-3. This is as true in developed as in emerging nations. Water prices for agricultural use are near zero in emerging nations. Water for agriculture costs more than \$1 per m^3 only in Netherlands and Austria. For the U.S., France, Greece, Spain, Hungary, U.K. and Portugal water for agriculture costs less than 10c per m^3. It is apparent that incentives for conserving water for agricultural uses (primarily irrigation) are virtually absent, except perhaps in the Netherlands and Austria. Therefore, the growing scarcity of water should come as a surprise to no one.

Comparative Water Prices by Country and by Sector:
Agriculture, Industry, Households (Late 1990s)



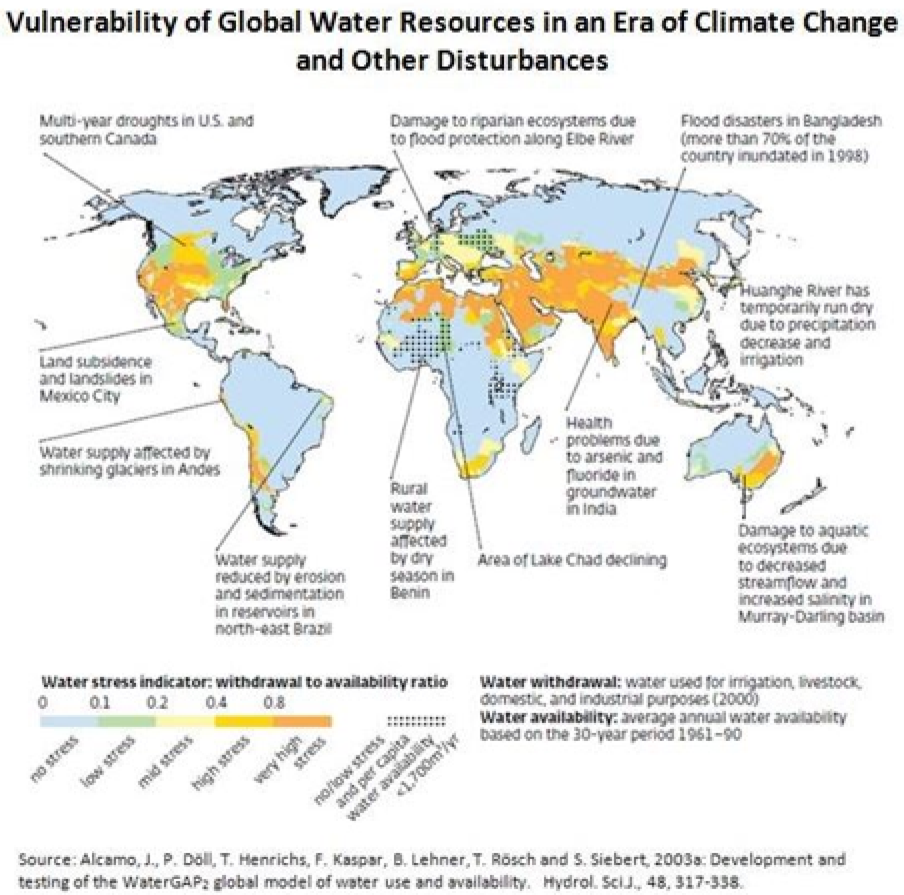
Source: Organization for Economic Cooperation and Development, Paris, 2001 (as cited in 2014 Texas Water Summit Report.

Climate Change and Water Availabilities

The consensus of conclusions from climate change models is clearly for future increases in surface air temperature in the next few decades. Higher surface temperatures will increase the frequency of days involving extreme temperature. One result will be increased evaporation from lakes, ponds, and soils, reducing water availability and intensifying droughts that develop naturally.[footnote]
The Academy of Medicine, Engineering and Science of Texas, 2014 Texas Water Summit Report, Austin, Texas, p.4.

This newer threat to world water supplies is developing at a time when supplies are already under stress from political conflict, periodic droughts worldwide, depletion of aquifers, contamination of groundwater sedimentation, and of course deep underpricing of water.

Figure 18-4 presents a synopsis of the vulnerability of global water resources due to climate change and many of the other factors cited just above.



Vulnerability of Global Water Resources in an Era of Climate Change and Other Disturbances

Multi-year droughts in U.S. and southern Canada
Damage to riparian ecosystems due to flood protection along Elbe River
Flood disasters in Bangladesh (more than 70% of the country inundated in 1998)
Huanghe River has temporarily run dry due to precipitation decrease and irrigation
Land subsidence and landslides in Mexico City
Water supply affected by shrinking glaciers in Andes
Health problems due to arsenic and fluoride in groundwater in India
Rural water supply affected by dry season in Benin
Area of Lake Chad declining
Water supply reduced by erosion and sedimentation in reservoirs in north-east Brazil
Damage to aquatic ecosystems due to decreased streamflow and increased salinity in Murray-Darling basin
Water stress indicator: withdrawal to availability ratio
0
0.1
0.2
0.4
0.8
no stress
low stress
mid stress
high stress
very high stress
no/low stress and per capita water availability <1,700m³/yr
Water withdrawal: water used for irrigation, livestock, domestic, and industrial purposes (2000)
Water availability: average annual water availability based on the 30-year period 1961–90

Source: Alcamo, J., P. Döll, T. Henrichs, F. Kaspar, B. Lehner, T. Rösch and S. Siebert, 2003a: Development and testing of the WaterGAP2 global model of water use and availability. Hydrol. Sci.J., 48, 317-338.

Sustainable Use of Water

What of the future? As usual, must be made with great care. Indeed some have described economics as a discipline whose practitioners have predicted eight out of the last five recessions.

OR as famed New York baseball player Yogi Berra once said: "“Making predictions is perilous, particularly predictions about the future.”"

The author ordinarily refrains from predictions but here are two:

1. Water: Fresh water will be an extremely coveted resource in the 21st century. People who find profitable ways to conserve and optimize on water use will make a lot of money and at the same time save a lot of human and animal lives in the process.

2. In the 21st Century more armed conflicts will be fought over access to fresh water than conflicts over religion.

For hundreds of years, societies and economics have paid scant attention to sustainable use of water. In economics 40 short years ago, students were even taught in principle courses the "water-diamond paradox", to explain why diamonds are expensive and water is cheap.

The paradox: water is much more useful than diamonds but diamonds are expensive because they are scarce. By contrast, water is free, or very cheap, because it is "plentiful". As a result, many generations grew up thinking water as a free good.

The consequences were disastrous - water was priced at next to nothing per unit, and consequently has been wasted in profligate fashion.

By 2009, the issue of sustainable use of water was at least as important to the world as sustainable use of energy or forests. And for emerging nations, the matter is even more serious, as we have seen, owning to three factors:

1. Continued population growth due to the momentum factor in emerging nations, even though fertility rates have slowed greatly since 1970
2. Continued economic growth in emerging countries, even if real rates of growth of only 2-3% materialize
3. As population and economic growth continue, one consequence will be a steadily growing stress on freshwater supplies through their effect on diets

Consider a few facts:
The most water intensive crops are, in declining order of water use:

Beef:	15,500 liters are needed to produce 1 kg of beef

Pork:	4,800 liters per kilo of pork
Chicken:	3,900 liters/kg
Wheat:	1,300 liters/kg
Milk:	1,000 liters/kg
Potatoes:	The lowly potato performs best, in terms of water utilization, requires only 900 liters per kilo

Armed with the knowledge now consider the evolution of diets as economy grow and change. In the past, families in very poor nations have typically relied heavily on vegetarian diets – grains, berries, flowers etc. Except in countries where cultural and religious tradition prohibits (beef in India, pork in Muslim world), the economic history of world since 1900 reveals clearly that rising incomes leads to a shift toward more meat in diets.

For freshwater supplies this is an important development. Raising a kilo of wheat requires 1000 liters of water. 15,500 liters of water are needed to produce a kilo of beef, at least 11 times that that for wheat.

An example of the wheat/beef trade off. In 1985, when China first began to grow rapidly, the average Chinese consumed 9.1 pounds of meat per year. By 2008 with per capita income at least twice that of 1985 the average Chinese ate 23 pounds of meat – 2.5 times as much in only 13 years.

More generally, as poverty decreases in emerging nations, we find that intensity of water use rises. As a result, the Food and Agriculture Organization of the U.N. estimates that by 2030 the world will need 60% more water for agriculture merely accommodate population growth and economic growth in emerging nations, let alone rich nations.

In spite of these considerations, governments all over the world continue to preside over the waste of water in such “green backfires” as the subsidies for producing corn for biofuels in the U.S., which was initiated in the vain hope of reducing global warming.

It has been estimated that over half of all government investments in agriculture in LDCs in the late 20th Century went into irrigation development. In Mexico fully 80% of all public investment in agriculture has been in irrigation projects. There, charges for irrigation water average only 11% of total costs. And in a sample of World Bank irrigation projects in LDCs revenues covered only 7% of project costs, on average. In most other countries revenue from farmers cover less than 20% of capital and operating costs. Again we see that when a resource is underpriced, it will be overused and wasted.

Very cheap prices for irrigation water have, of course, resulted in very high rates of water waste, whether from the Colorado River, the Indus River, or the Aral Sea of the former Soviet Union. In sub-Saharan Africa, 42% of the population lacks access to improved water sources, and regional water shortages are very serious. Before long local water issues could become easily global and wars may be fought over water.

What can be done?

First it must be recognized that the overuse of drinking water for households is not a major cause of the problem, but again substantial water is wasted by:

1. Under pricing of drinking water
2. Very large leaks in local water systems that are under-maintained and in ill repair (i.e. Indiana, New York City)

However, economic history reveals that the first spending category governments cut in a crisis is maintenance (Universities too). There is a very simple and equitable solution to this part of the water problem:

The adoption of pricing systems that provide low income households with the minimal water they need at low costs while charging increasingly higher rates on all water consumed above that minimum. This is one good way to get “more equity in the ecosystem.”

Example: People across the world, on average, drink under 2 quarts of water per day. Medical authorities consider 2 quarts per day to be the minimum standard. Rich countries tend to reach this level. Poor nations typically fall far short of the minimum.

So, where there are water distribution systems with meters then, households would be charged a low base price say for all water used below, say 10 gallons (20 quarts) a day (for a family of 5). Then for next 10 gallons the charge would double, for the next 10 gallons the price per unit would be triple the base price, and so on.

In several really poor nations, households without water connections use stand pipes located at intervals within villages and urban areas. Here, it is sensible to provide free all the water they can carry. When one has to carry water by hand for ½ a mile or one of more miles, one tends not to waste it.

Water meters clearly help conserve. For those fortunate enough to have house connections, water meters are an excellent way to enforce water restrictions, especially higher water prices for excessive water use.

I have often heard, however, that you can’t enforce conservation with water meters and these can’t work in poor areas; people will smash them. This has not been the experience in most nations, including material water systems in Bogota and Santiago.

Also, the other side of the budget may be used to combat water wastage, if the higher water charges are used to finance the following:

1. Maintenance and repair of water systems (to end big leaks).
2. Subsidization of programs for water recycling, basically utilizing wastewater for industry and agriculture (grey water).
3. Subsidization of water storage kits for households (rain barrels etc.)

An Indian Example

Since the “License Raj” ended in the 1980s, India shows signs of becoming something of a hotbed of new, bottom-up, market oriented solutions to both help poor people and improve the environment. In Andhra Pradesh, a foundation is using a pay-per-use model to deliver clean water to a million people. Households buy one 12 liter container of water per day, at cost, from water filtration plants. Moreover, they get back what amounts to a rebate, if 500 households get together to buy the containers.

So there are sensible options for water pricing to households. But remember that in developing nations 70% of water is used in agriculture and everywhere it is heavily underpriced.

So a major part of the solution is to raise water tariffs for irrigation sharply.

Worldwide, 20% of water is used for industry. The solution here is to raise water tariffs on industry and then turn around and use the revenue to subsidize water recycling.

Privatization in Argentina, Bolivia and Chile

An alternative solution may be, in some nations, privatization of the water supply, so that markets may play a role in promoting sustainable use of drinking water. In most of the world, provision of drinking water is dominated by small, inefficient government departments or government owned enterprises (as in India). But in dozens of countries, infant mortality from unsafe water remains very high. What can happen when reliance is placed on market mechanisms instead of government enterprises to provide water? Here is one example.

In the 1990s, Argentina embarked on one of the largest privatization campaigns in the world, including the privatization of local water companies covering approximately 30% of the country’s municipalities. Argentinean researchers later found child mortality fell 8% in areas that privatized their water services overall; the effect was largest (26%) in the poorest areas. Privatization was associated with significant reductions in deaths from infectious and parasitic diseases. However, the Argentina program died due to politics.

So, can privatization of water distribution sometimes yield the expected results? Experience suggests yes, according to a recent Report of the World Bank.[footnote]
See the World Bank study by Gassner, Popov and Pushak, *Does Private Sector Participation Improve Performance in Elec. Power and water distribution?* Washington, DC: World Bank, 2009.

Using data from all over the world, from emerging nations in Latin America, Asia, Africa and Mideast the author shows that privately run water and electric power companies outperform government owned enterprises in:

- Production
- Operational efficiency and probably
- Sanitation
- Avoiding water wastage

The only negative they observe in water privatization was staff reductions. State-owned firms in almost any activity anywhere tend everywhere to have 20%-50% more workers than needed for the job. Payrolls are often padded with political supporters of the government.

Privatization was tried also in Bolivia in the early years of this century but ran afoul of politics.

Privatization of water supply in Chile began in 1990. In the period 1990-94, average prices for water were increased by 90%, to enable prices to cover the marginal of providing water. Water consumption fell by 10% over the period even as the population and economy grew substantially.

Did the poor suffer? The poor never need to suffer from policies to secure sustainable of water, energy or even food.

To protect the poor, Chile provided a 2-prong subsidy program:

1. Poorest families received a 15% discount on water use.
2. The poorest families got a direct cash subsidy to cover higher water cost. The subsidy reached 95% of poor households.

Earlier, we stressed that water issues extend well beyond possible shortages of supply. Water quality also needs to be considered.

Consider, for example, China in 2014. Contaminated groundwater has become a really serious problem in China, as we noted earlier in this module. About half the population uses water supplies heavily polluted by animal, human, and industrial waste (some of this pollution is now showing up in Chinese exports of wallboard and other products).

Chinese cities are seriously polluted by sewage. The Chinese Academy of Sciences stated in 2005 that 21 cities along the Yellow River register dangerous levels of contamination in foodgrains (especially rice) and other food stuffs. Just to achieve a 50% treatment rate, China would have to build 10,000 new sewage treatment plants. Clearly for China, there is no environmental problem more serious than that for water.

Finally, China is beginning to take steps to rectify its abuse of water resources. In 2009 Shanghai and Beijing both raised water prices substantially. Shanghai rates increased by 25%. There was another 22% raise in November of that year. In Nanjing rates went up by 12%, but direct subsidies were given to the poor to compensate them.

More countries are beginning to recognize the role of pricing in water conservation. Indonesia uses a flawed system called Pasten. Jordan, a very arid country, has adapted a pricing system that encourages farmers to select water efficient crops (not cotton). Chile has introduced a spot market for irrigation water, which relies on the buying and selling of property rights to water. This has notably reduced use of irrigation water in the valley south of Santiago.

We close on a somewhat positive note. Not all developing nations face severe or acute shortages of water: Brazil is blessed with water, even after it destroyed so much of the tropical forest.

Brazil has 8,000 billion cubic kilometers of renewable water each year. This is #1 among all nations, and is more than for all of Asia alone (with 4 billion population). Brazil’s population is approaching 250 million. So Brazil’s per year capita availability of water is 32 times that of Asia.

With this very generous water endowment, and with very good Brazilian research on tropical agriculture, Brazil in 2011 became the largest food exporter in the world. This has all been done without any significant government support, except for subsidies on seed research.

NATURAL CAPITAL: FISHERIES

Introduction

Portions of this book were finished in 2015. Had this chapter been written five years earlier, the general tone regarding fisheries would have been decidedly pessimistic: fisheries worldwide were being rapidly depleted, in spite of conservation efforts discussed below.

However, thus far into the 21st century the world has benefitted from very rapid growth of fish farming in the U.S., Nordic Nations, China, Thailand, Malaysia and Chile. Modern fish farming includes saltwater varieties popular in the diets of people in both developed and emerging nations. If the fish farming industry continues to mature and spread to more countries, future editions of this book may contain a very short chapter on fisheries. Then, what we now view as natural capital will be essentially manufactured capital. It is still too early to celebrate this achievement. Farmed fish may prove to be susceptible to diseases not common to fish in the wild. Fish farming also involves some environmental risks. And some farmed fish do not satisfy human palates as well as the same fish caught in the wild. For example, this was apparently the case for much of farmed salmon from the U.S. and the Nordic countries early on: the farmed fish carried a distinctly different taste. However, the industry seems to believe that this problem will disappear as time passes.

For the time being, at least, the rapid rise of fish farming has materially helped in reduced depletion and stress on natural fisheries. In any case, the world's natural fisheries remain as an important source of natural capital for emerging and developed nations and will be treated as such. (Details on the farmed fish industry are provided later on in this Chapter).

Significance of Fisheries

Fisheries involve issues of resource sustainability that have been largely overlooked for far too long. Abuse of this source of natural capital has worldwide implications, especially as fish pertain to the diet and employment opportunities of poor people in poor nations.

World trade in seafood of all kinds totaled $136 billion in 2013 excluding farm-grown fish.[footnote] Worldwide, in 2006 200 million people were employed in fisheries. In poor countries almost 95% are employed in small scale fishing. Worldwide, 2.9 billion people depended on fish for more than 14% of their protein. 20% of the world's people, mostly in the poorest nations rely on fish as their primary source of protein.
"Unchartered Waters", *Financial Times*, Nov. 21, 2014.

As has been the case for water resources, awareness of fishery resources issues only began to become widespread after 1950. Why? In 1950 only 50% of the world's fisheries were fully exploited. By 1980, this figure rose to 60%, and by 2008, 80% of fish stocks had been fully exploited. The population of certain highly prized fish species has fallen precipitously. For example the number of Pacific Bluefin tuna in 2012 was but one fourth that of 1995, and one seventh that of the mid-sixties. By 2010 the situation for bluefins had become serious.

In the worst case, world fisheries were moving toward complete collapse before 2050. We will see that the most important overexploited fisheries suffer from overfishing resulting from the "Tragedy of the Commons". Without regulation, without clear and secure property rights. As a result, "individuals maximize their own welfare by a series of decisions that result in overexploitation. Once again: a resource that belongs to everyone belongs to no one. The rise of farm-grown fisheries may however, delay or even forestall this collapse.

Other factors contribute to overfishing, however. These include in some nations subsidies to diesel fuel (used by most fishing boats). This is not a trivial matter. To land one metric ton of shrimp and lobster requires 2,923 liters of diesel fuel.[footnote] Another major cause of depletion of fish stocks has been inappropriate regulation of by-catch, (the unwanted species caught when fishing for other species). Finally, many existing regulations in fishing are perverse. With a common pool of resources (the ocean) fishermen will "continue to fish as long as the value of [the] catch exceeds the cost of catching it".[footnote] But this kind of fishing is unsustainable. As a result, the cumulative amount of fish caught exceeds the sustainable level and jeopardizes future fish stocks. Over time, several different

solutions have been proposed in order to try to resolve this problem. We will discuss ITQ's as one attractive option (Individual Transferable Quotes).
Science, August 1, 2014, Vol. 345, p. 494.
Beddington et al., "Current Problems in the Management of Marine Fisheries", *Science*, June 22, 2007, Vol.316, p.1713.

In discussions of sustainable use of resources including fisheries, the aim must be not only to facilitate more "efficiency in the ecosystem," but also more "equity in the ecosystem." And, as we have seen in forests or with water and will see time and again, one doesn't get very far in improving efficient use of the ecosystems unless something is also done about equity especially in poorer nations. This means that as with natural resources as forests, water or fisheries we must consider always the interests of the poverty-stricken, the landless poor, and the small-scale fishers.

Here again we see how interdependencies matter greatly in economics. What is done in energy affects the global climate which affects what happens in water. What is done in energy and water, especially in measures to deal with climate change, have very great effects on the world's fisheries. Evaluating measures affecting energy and water without also considering their effects on fisheries in not good ecology and not good economics. That is one of the most important lessons you may take away from this book. Another lesson is that economic and scientific issues are involved. It is to be hoped that by the time you finish reading this chapter, you will be prepared to identify and explain inter-relationships between sustainable energy use, deforestation, water scarcity and quality and fisheries depletion.

Dealing with Fisheries Issues: Salt Water Fisheries

We first discuss issues in saltwater fisheries, the most important source of fish. A later sector deals with issues in Freshwater Fisheries.

As is the case for conservation of other forms of natural capital (energy, water, forests) sensible approach requires a portfolio of policies. No panaceas are available. We will first examine some market-based measures.

ITQs Individual Transferable Fishing Quotas: A Market-based Approach

Many economists and ecologists believe strongly that innovation in property rights can halt or even reverse trends toward collapsing fisheries. [footnote] Under ITQs, instead of exhortation by politicians, incentives for conservation of fisheries are provided. Fishers are granted shares in the allowable catch (defined usually as some percentage of last year's catch). ITQs are common in Iceland and for Halibut and Salmon in Alaska. Notably, a series of articles in Science magazine, the Economist and others have shown that ITQ managed fisheries are sufficiently less prone to collapse then non-ITQ fisheries.

How do ITQs work?
See Science, September 20, 2008.

One first establishes a seasonal or annual quota for the type of fish being caught. The quotas are a percent of the total annual (or seasonal) allowable catch (TAC) (to be discussed in detail below). Briefly, the allowable catch is determined by Ichthyologists and other marine specialists. The allowable catch for any given region can vary from year to year, depending on estimates of the health of the fish stocks.

Then each fisher is allowed a certain number of ITQs. The fisher can use the ITQ, or he can sell it to others, who can harvest the fish at any time during the fishing season. In this way boat captains can plan the season's fishing without worrying about weather. And more importantly, the captains need not worry the risk that other fishers will gobble up the common property resource. The latter is called race-to-fish. This is what tends to happen if instead of ITQs an effort is made to regulate the catch by banning fishing except for very short seasons (say a one-week season). In this situation, captains tend to fish day and night surrounded by dozens of boats also trying desperately to catch enough before the short season expires.

How do typical ITQ systems work? Iceland experienced a collapse in many fish stocks in 1969-74. ITQs were Iceland's response. All ITQ systems (Iceland, New Zealand, and Alaska) began with the establishment of the TAC- Total Allowable Catch. The TAC is an estimate by fish biologists. It takes into account the estimated stock, the lifetime of the fish species, and the amount of fish that can be withdrawn from the stock and still allow sustainable fishing. (Sustainable fishing: fishing that does not diminish the size of the stock for future generations).

The TAC is expressed as a fixed % (20-25%) of the total stock. In the next step, the authorities sell a certain percentage of the TAC to fishers as a long-term "individual transferable quota (ITQ)." The ITQ is transferable. It may be used by the fishermen awarded the ITQ, or he/she can sell it. This ensures that fishermen pay according to the amount they catch and gives fishermen an interest in the future of the resource. It also materially mitigates the highly destructive "race to fish" found in older regulatory system (3 day seasons, etc.)

Consider Iceland as an example. The Iceland ITQs give the ITQ holders the right to catch fish within Iceland's economic zone (defined under international law). The catch is limited to the individual quota assigned to fishermen.

The ITQs are

1. Permanent (long term)
2. Divisible
3. And freely transferable- i.e. they can be freely bought and sold.

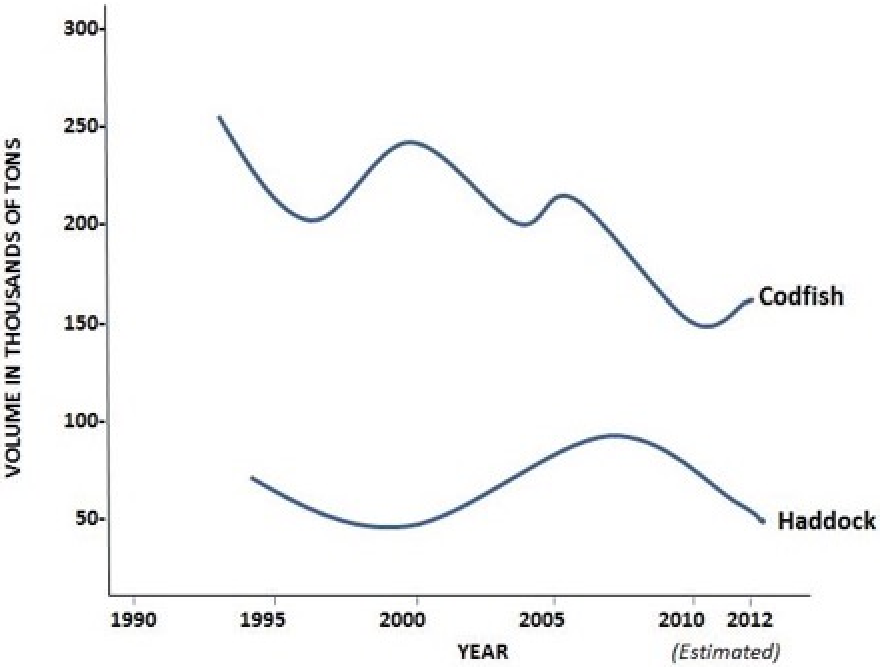
In Iceland fisherman awarded ITQs pay a yearly fishing fee that is 9.5% of their estimated catch for the previous year. This is not usual under ITQs (most elsewhere the ITQ is free). Among other things, this fee supports enforcement activities for ITQs.

So, in Iceland, if the individual fishers catch in **2013** was valued at $1 million Kroner, in **2009** the fisherman pays 95,000 Kroner. In any case, the ITQ places fishing rights (quotas) in the hands of the most efficient fishers. These fishers are willing to buy the quotas of less efficient fisherman. Indeed, the less efficient fisherman may well decide to stop fishing altogether and sell their quotas if the value of the quotas increases enough (in fact, the total value of the freely traded ITQs in Iceland rose from US $500,000 in 1991 to $4.5 million in 2004).

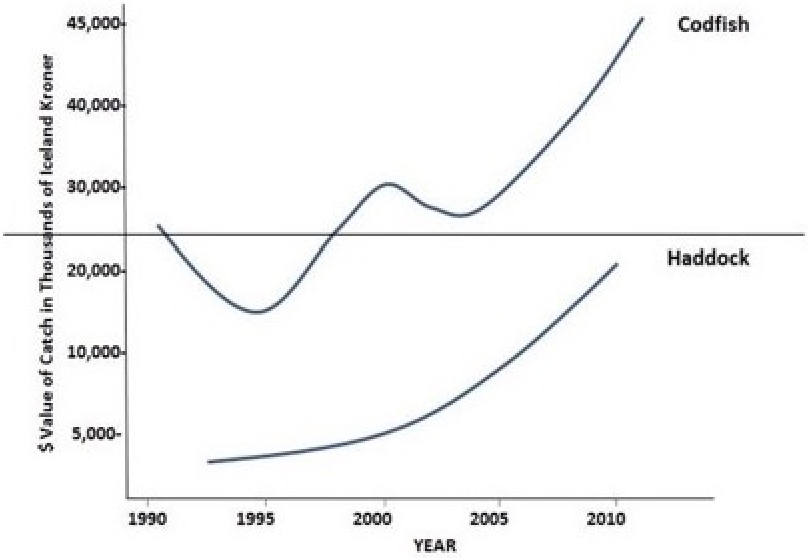
Note one particular valuable feature of an ITQ system. If for some reason the government decides that there is an unexpected decrease in the fish stock because the TAC was too large in the past, or because the fish stock is declining too rapidly for other reasons (climate change, disease), then, the government can simply step in and buy back some of the ITQs it had already awarded, thereby decreasing the permissible fish catch for that year.

How well have ITQs worked in practice? Consider economic and biological effects since 1991 in Iceland, New Zealand, and Alaska. In Iceland fishing is typically about 12% of GDP, 7% of the total workforce. Iceland was the first to use the ITQ (see Figure 19-1).

Economic Effects in Iceland- Codfish is by far most important fish (others include Haddock, Redfish, and Saithe). The implementation of ITQs has resulted in a decrease in the volume of fish caught. That was expected and intended. It has, not surprisingly also resulted in anincrease in the value of the catch (see Figure 19-2), a welcome outcome for fishermen. This system was partly adopted in 1986, and fully implemented in 1991.



Iceland: Volume of Catch over Time
(By Species)



Value of Catch

Source:
Results for years 1998-2002 were not so good, because fish biologists overestimated the total stock of cod, and therefore resulted in a TAC “too high” value of catch in icelandva.

Why did the value of catch increase so much in Iceland.

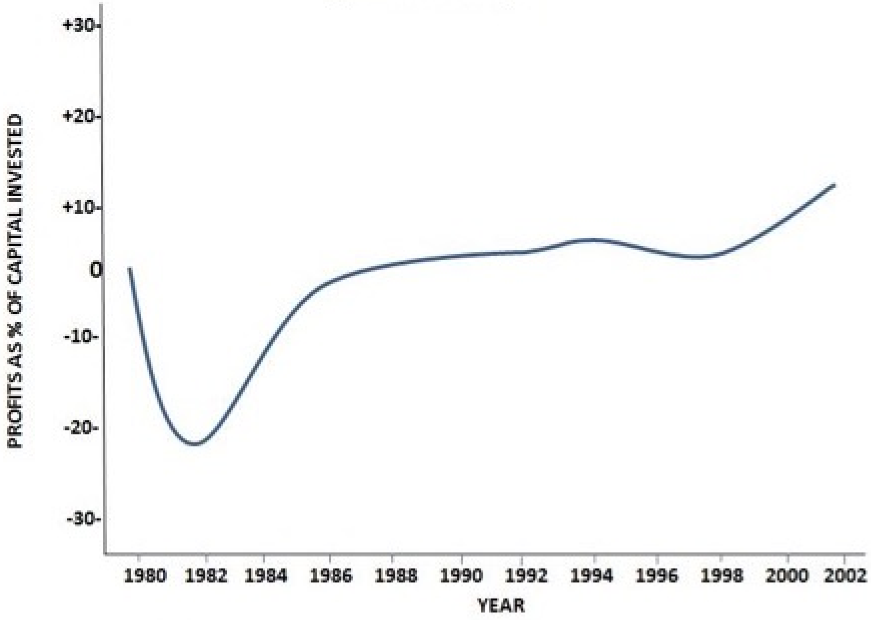
1. Quantity supplied decreased, so prices increased
2. Before ITQs, the total catch was limited by effort quotas (number of days you could fish). Fishermen had to catch fish when they could, not when prices were high.

Now with ITQs, Cod and Haddock are brought to market when prices are highest (seasonality issue).

What about profitability of fishing in Iceland under the ITQs?

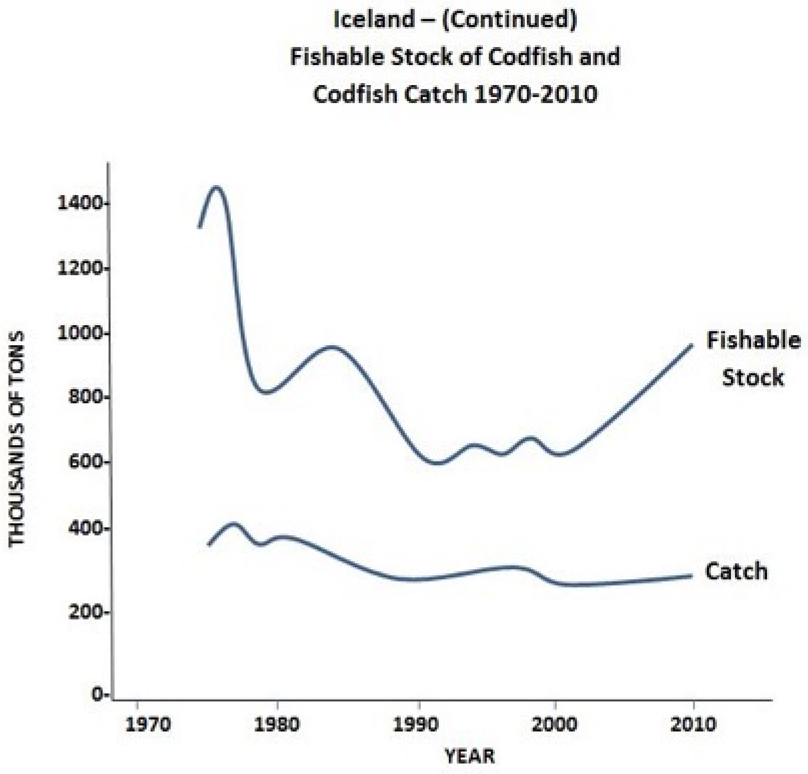
That has gone up as well (see Figure 19-3).

Iceland – Continued
Profits of Fisherman – (Before Taxes)
(1980-2002 only)

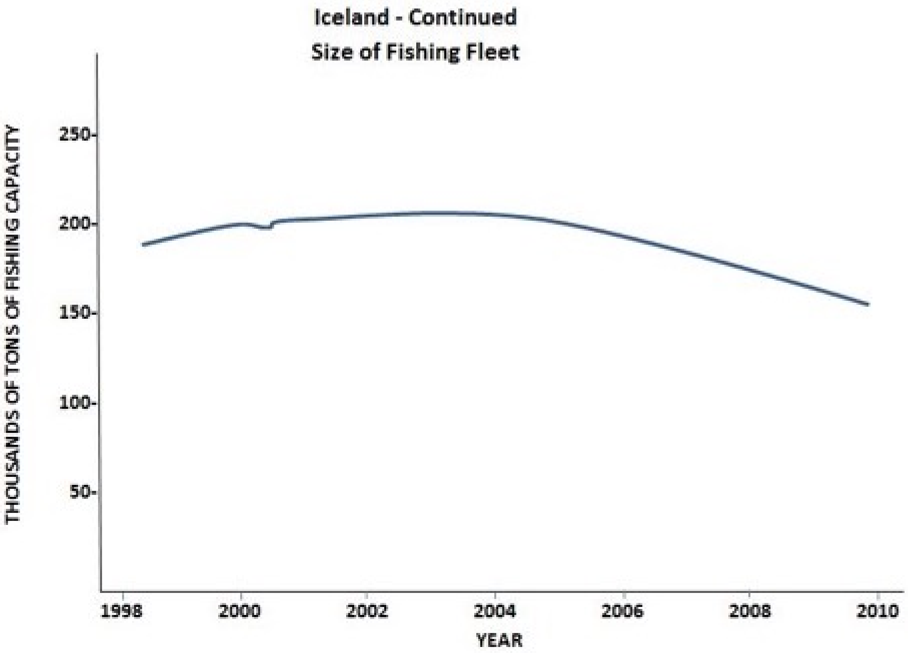


NOTE: Present ITQ system introduced in 1991. A partial system was in effect 1985-90.

Figure 19-4 shows what happened to the fishable stock of codfish (the total resource over time).



So, what was intended did occur: the total volume of the catch fell, the fishable stock increased, and fishing profits went up. The Iceland system has also achieved two other objectives – reducing the number of fishing vessels and reducing the overall capacity of the fishing fleet, as can be seen in Figure 19-5.



Consider the number of fishing vessels as the measure of capacity. This declined by 42% from 1992 to 2002. Although the size of the fishing fleet size did sharply decrease in terms of number of vessels, overall capacity declined only from 180 thousand tons in 1998 to 150 thousand tons in 2008. Why? Because the size of remaining boats became larger. So, the system also helped to increase efficiency in fishing fleet.

Important lessons have been learned from the ITQ systems in Iceland, New Zealand and Alaska. Successful operation of ITQs requires good institutions, good governance and ready accessible, affordable technology. Iceland holders of ITQs have to keep logbooks or board recordings each day's catch. They must all carry on board equipment that sends out electronic signals showing the location of the boat.

Effective enforcement is critical. Twice a year, each vessel is likely to go to sea with a government inspector on board, to observe fishing practice and handling of “by-catch.”

Clearly then, innovations such as ITQs can promote sustainable fishing. How large are the costs of unsustainable fishing? A World Bank study in 2009 estimated the economic cost, arising from three sources:

1. Commercial over-fishing around the world
2. Poor fisheries management
3. Other inefficiencies

These three factors added up to $2 trillion over the past 30 years[footnote] ($50 billion year). (This does not include economic losses due to recreational fishing). These are needless losses, because they could be avoided with appropriate reforms.
“The Sunken Billions: The Economic Justification for Fisheries Reform,” Washington, DC: *The World Bank*, 2009, p.49.
What accounts for the high cost of overfishing?

- Depletion of fish stocks mean of course fewer fish. Fewer fish means fish are harder to find, and harder and more expensive to catch.
- There has been overcapacity of fishing fleets around the world, so economic benefits of commercial fishing have been dissipated due to redundant investment and operating costs.

Just about anything that reduces the size of the world’s fishing fleet would aid sustainability of fish stocks.

Fishery stocks have been in decline everywhere, both in salt water near the U.S. and Europe, and in waters off Africa, South Asia and Latin America. However, the combined result of ITQs on depletion of key fishing grounds and most recently commercial fish farms has stabilized the catch of wild fish at about 90 million tons per year. There has also been a decline in fresh water fisheries. The obvious answer is overfishing (noted earlier). Another reason- environmental run-off has been poisoning the water killing fish as in waters such as the Gulf of Mexico as a result of the U.S. Ethanol subsidy (see previous chapter).

First look at issue of overfishing. Why has there been too much overfishing?

1. **Excess capacity** in world’s fishing fleet a problem aggravated by government subsidies to fishing. Some countries have blundered into the ridiculous situation wherein the costs of government subsidies to fishermen exceed the total value of the annual catch.

2. **Institutional Problems** - lack of tradable property rights in fishing. This is slowly changing now as we have seen, due to ITQs.

How serious is the problem?

- In Europe 88% of fish stocks were overfished by 2008
- In the North Sea – 93% of Cod caught before they can breed
- In Indonesia in the Java Sea there has been a growing scarcity of edible fish. .
- In Peru, pacific current (Humboldt current) fisheries are under increasing strain.

Market-based and regulatory approaches are required if overfishing is to be reduced.

We note that market-based solutions do not always work. But why do you think that governments (Presidents, Legislators, and Bureaucrats) favor regulatory mechanisms, while disdaining market-oriented approaches to environmental ecological or other problems, even when the market oriented measures work?

Market-based approaches involve less concentration of power in the hands of Presidents, Legislators and Bureaucrats. And once a regulatory program is adopted it tends to have eternal life, with vested private and public interests in continuing the program. In the U.S., for example very few federal regulatory programs enacted in the past 50 years have been allowed to expire.

Market-oriented measures can help, but market solutions to overfishing are not any kind of panacea; often regulatory measures are also required.

Consider again: Fish stocks are a common property resource. Commercial fisheries will always overfish unless they are restrained by either regulation or changes in property rights to fish. Why will commercial fishers overfish in the absence of restrictions?

Their focus everywhere – in New England, in Alaska, in Java Sea etc. is essentially short-term in nature. Commercial fishers have long basically demanded the right to “cut off their fingers, one at a time.”

What does this mean? It means:

“Fish the resource until it is gone”. Much of the overfishing problem is due to illegal fishing. Illegal fishing involves taking fish from areas that have been closed to fishing to prevent collapse of fishing stocks. (This was a severe problem in Lake Victoria in Africa).

Fraud, in mislabeling of fish for sale has been another issue involved in overfishing of certain fish species. Example: Bluefin Tuna fishing has been banned in many areas because Bluefins are endangered. So fishermen who catch Bluefins simply label them as another type of tuna and sell on markets. Bluefins are extremely valuable fish. In Japan in 2013, a 489-pound Bluefin sold for $1.8 Million. [footnote]
(*The Telegraph*, January 6, 2013). Retrieved from: http://www.businessinsider.com/bluefin-tuna-sells-for-record-breaking-18-million-2013-1.

The extent of illegal fishing worldwide is significant. According to *Science*, illegal fishing amounts to about $23 billion per year[footnote], or about one-fifth the total global fish catch of $136 billion in 2013.
Science, “To Fight Illegal Fishing, Forensic DNA Gets Local”, December 10, 2010, Vol. 330, p.1468.

A major example of illegal fishing is that for Sharks, a fish at the top of food chain in the ocean. The impact of overfishing of sharks is especially serious. This problem is becoming acute in the Western Pacific, in Java Sea and the China Sea. This is because of the use of shark fins for shark-fin soup, especially highly prized in Japan and China. The rest of the Shark is thrown away.

Here ITQs and regulation are failing badly. Consider Hammerhead Sharks and Sand Bar Nurse Sharks. These are among the most endangered of large predators. Sharks in U.S. waters were nearly depleted. In 1950s, due to over entry in shark fishing, most of the U.S. firms in this business went bust in 60’s. As a result the decline in the shark population was reversed in U.S. waters after 1962.

But overfishing continues in Mexican waters. Sharks were so depleted there that poachers now come into U.S. waters in search of sharks. In 2012 Shark fins sold wholesale for $36 pound, even more than the price of fresh Halibut. The worldwide trade in shark fin is estimated at $1 billion.

Illegal poaching by Mexican fishermen account for 50,000 sharks a year. The boats use long lines and gill nets. This is a very good example of enforcement problems. ITQs are not affected because of illegal poaching. But the Coast Guard in U.S. cannot police the whole Gulf coast for illegal drugs, much less shark poachers. As a result, Hammerheads, Sand Sharks and other shark fisheries remain in danger in the Gulf of Mexico and elsewhere.

As we consider issues in salt water fisheries, we need to bear in mind that emerging nations now have a much higher stake than before in reform of fishing practices that endanger this natural resource.

In rich nations, fishing is not a significant share of GDP. There is only one developed nation where fishing accounts for more than 1% of GDP: Iceland at 12.5%. The fact that about 75% of the ocean's fish species were until very recently on the brink of falling below sustainable levels adversely affects all of humanity, but it affects poor people in poor nations even more.

Several poor nations rely heavily on fishing. Examples include Peru, Thailand, Vietnam, and Indonesia. And diets in many emerging nations are heavily dependent upon increasingly scarce fish. (Note: The taste for fish is not universal. Apaches in the U.S. refused to eat fish even well into 20th century).

There has in fact been a shift of fishing effort from rich to poor nations. This shift accelerated beginning in 1960s. A growing problem has been foreign fishing fleets especially from developed countries doing illegal and unreported catches in waters adjacent to poor nations. But the fish caught by these fleets are largely consumed by rich nations, especially Japan, not poor ones. [footnote]

"Rebuilding Global Fisheries", *Science*, July 31, 2009, Vol. 325(5940), p.584.

Ecological Issues

The prime targets of salt-water fishing fleets are the predators of the ocean (cod, grouper, salmon, and shark). In many areas, 90% of these predators are gone. In Nova Scotia Cod are now 98% depleted. APEX fish are especially at risk. These are long-lived and epipelagic species (fish living near the surface). Overfishing for this high-value, long-lived fish is becoming increasingly serious in the Caribbean, Peru, Brazil and elsewhere. Consider Tuna, Mackerel, Swordfish and Marlin. In 2013 these all brought high market values $8-$12 per Kilo ex vessel and $18-24 retail (Bluefin Tuna was much higher). These epipelagic species are exploited by multifunctional fishing fleets (fishing boats with processing facilities aboard). Regulation of these is quite difficult. Most endangered is the Bluefin Tuna, a favorite on the Japanese dining table. Such fish are especially vulnerable to collapse from fishing pressure. They are all highly valued, long-lived and large bodied fish (some Marlin weigh upwards of 400 lbs.). It is easy to see why high value and large weight increase vulnerability.

The long-lived trait is ecologically significant. Marlin and Swordfish can live for as long as 15 years, with breeding after 6 years. If they are overfished decreasing average age and shortage of breed stock will result, and fish stocks decline.

The situation is so serious for Bluefin Tuna that the fisheries are approaching collapse.

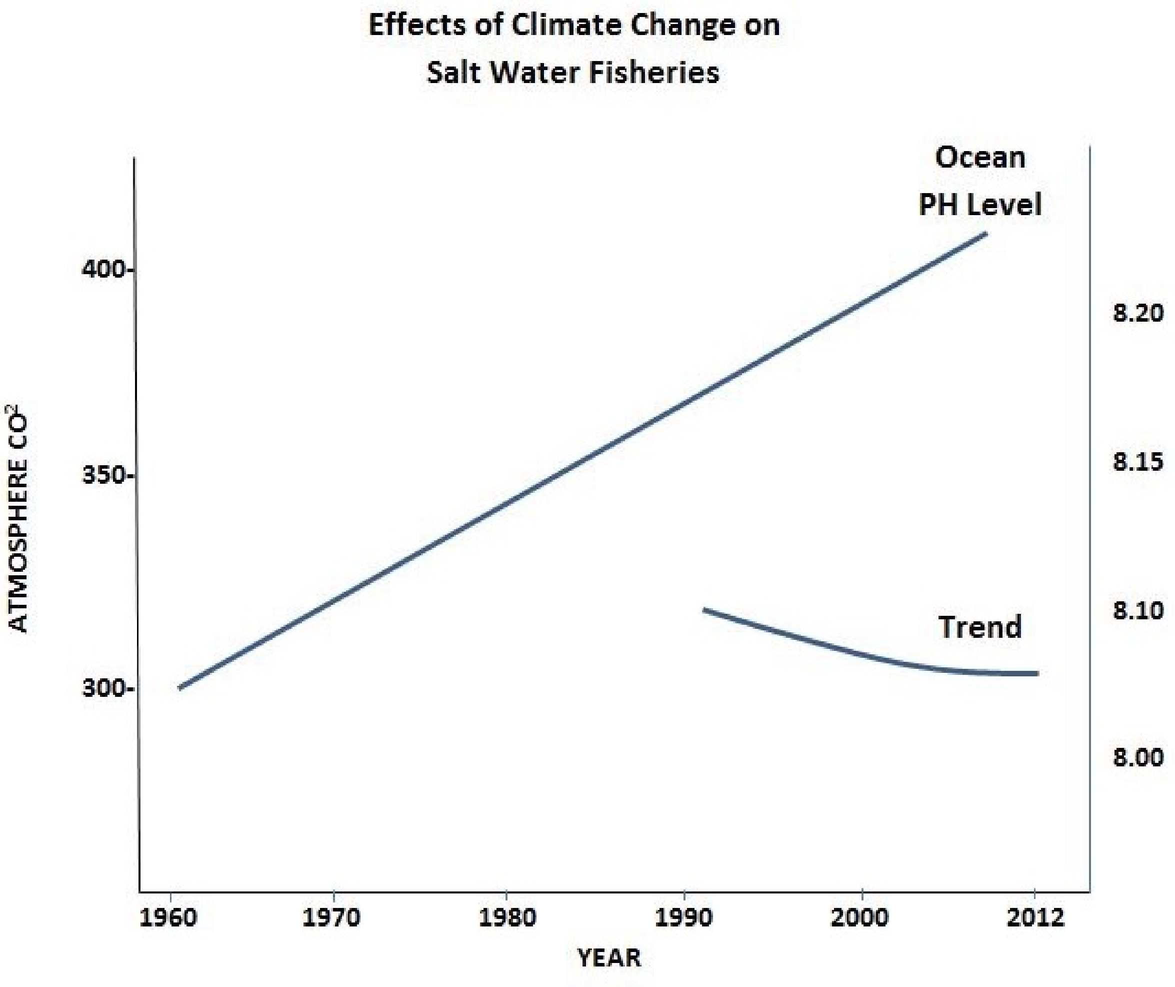
Effects of Climate Change on Salt Water Fisheries

We have seen that overfishing is destroying fish-stocks. Climate change also plays a role. How? Growing CO_2 emissions mean that more greenhouse gasses CO_2 enter the atmosphere. Then about 1/3 of atmospheric CO_2 is taken up by oceans. Result: with more atmospheric CO2 the ocean becomes more acidic. This can become a serious issue in the life cycles of fish.

There are already dire predictions concerning the effects of increasing CO_2 in the atmosphere from fossil fuels, deforestation etc. This is especially serious for fisheries and the world’s poorest: 15% of their protein comes from fish.

The primary problem for fisheries arising from climate change that increases acidity in the world’s oceans is especially serious in the extreme southern and northern regions.

Recall from basic chemistry a lower PH number means more acidity in some ocean waters. A fall of one PH point represents a tenfold increase in acidity in some ocean waters. Vinegar, for example is quite acid. From the late 80s to 2012, acidity has increased from PH 8.11 to PH 8.06, largely as a result of higher atmospheric concentration of CO_2.

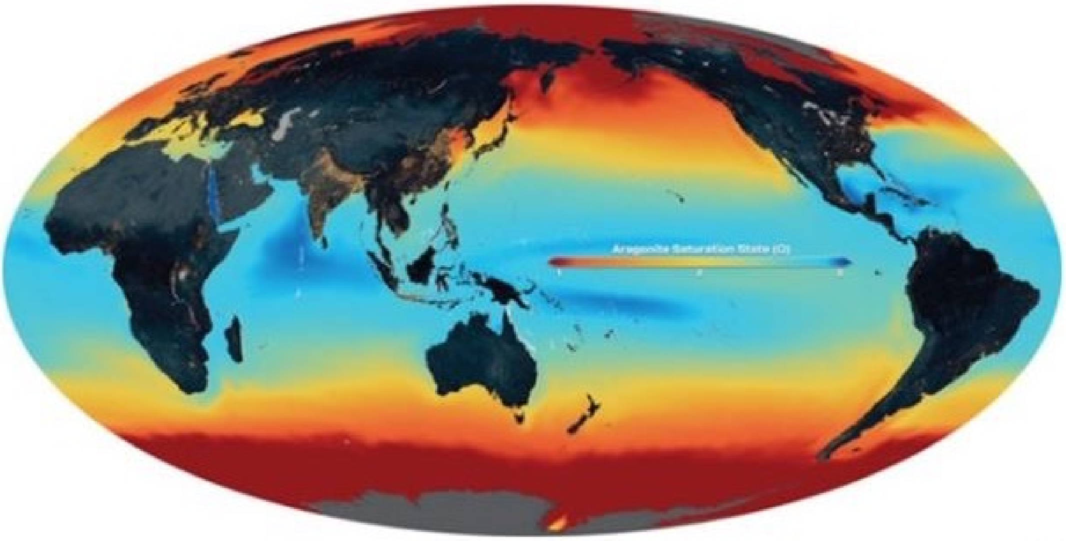


The fall of 0.5 points in PH in the last three decades represents a rise in ocean acidity of about 12%. Further, the best estimates suggest that there has been a 26% rise in acidity since 1820, when the industrial revolution began. The corrosive effect of rising ocean acidity on fisheries depends largely on how it affects aragonite. Aragonite is one of the forms of calcium carbonate. Coral reefs and virtually all mollusks (scallops, oysters, clams etc.) utilize much Aragonite in their skeletons. Omega is a number describing the threat of acidification to shellfish and coral. It depicts the aragonite saturation rate (see Figure 19-7). An Omega value of ONE is the critical level of acidity. Below a level of one, shells and skeletons made of calcium carbonate will dissolve.

Some sea animals, however, require a much higher omega level. Corals in particular require an omega level of 3 to grow their reef-making skeleton. Figure 19-7 shows that only relatively small portions of the Atlantic and Pacific are predicted to have omega levels >1.

In the mid-20th century near-pristine coral reefs hosted billions of fish, a favorite fish habitat. Ocean acidification is not the only reasons for the rapid decline of coral reefs worldwide. Deforestation in the Philippines, Thailand, Indonesia, Brazil and other nations has played a role as well. Growing deforestation leads to growing siltation of rivers. Ultimately this runoff reaches many coral reef formations in the ocean stifling reef growth. A final cause of coral reef decline has been dynamiting of reefs, where concussion from the explosions also kills fish on a large scale.

Given these pernicious influences, only about 55% of coral reefs in 2010 were considered pristine. And 25% of living reefs are gone forever. Finally, as we shall see, all coral reefs are vulnerable to global warming.



Potential Acidification of Oceans
Long Term

Predicted: 2100
Red is "bad"
Blue is "good"

Science, November 14, 2013, p.76-77

Falling levels of Omega are serious threats to the lower regions of the oceans food chain. Eventually, fisheries would be greatly affected. But at this point, we have little idea what fisheries and what species will be damaged most.

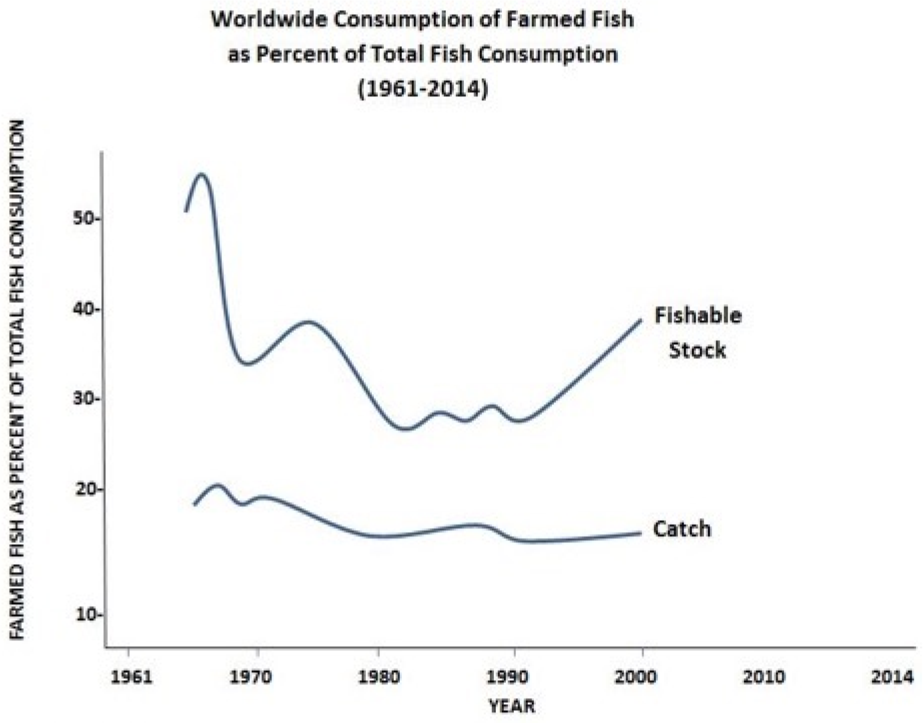
We do know that 56 million years ago (10 million years after mass extinction of dinosaurs), the oceans became very acidic due to climate change. Then, there was a 6 degree centigrade increase.

The map in Figure 19-7 indicates, among other things, that all coral reef formation could one day cease.

Consider the map again. Why do we see such low predicted Omega values near the South and North Polar Regions? Because colder polar waters dissolve atmospheric CO2 much more easily than tropic waters.This is a problem that, if it does materialize, will be quite serious for the next three generations behind the reader.

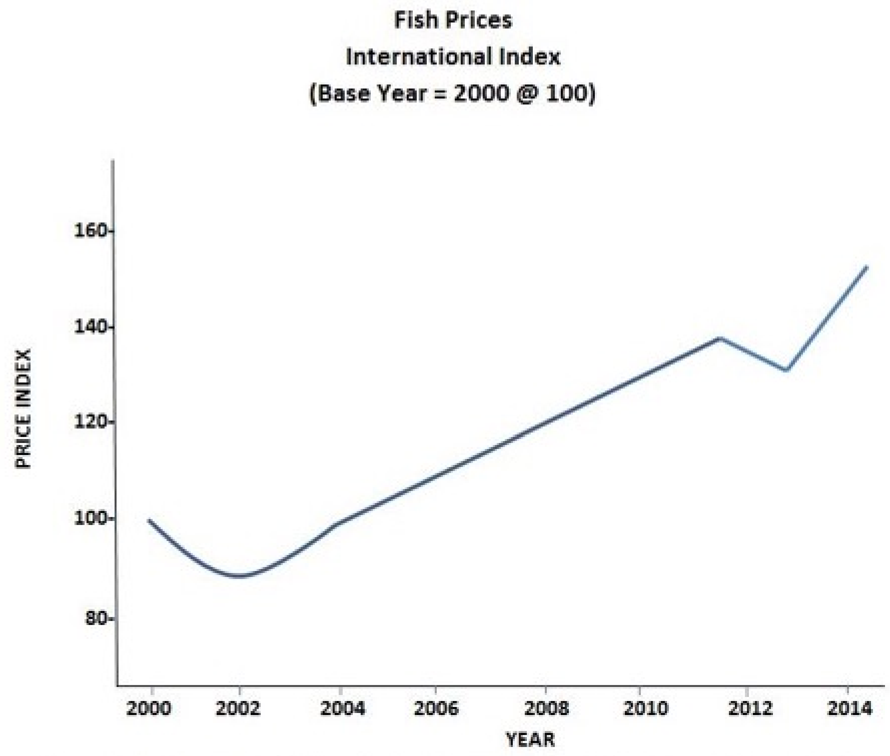
Commercial Fish Farms and the Future of Natural Saltwater Fisheries

Until the mid-eighties, commercial fish farming was a relatively small industry worldwide, mostly concentrated in farms raising Pacific Salmon (in the U.S.) and Atlantic salmon (in Northern Europe, especially Norway). But in the past two decades, worldwide production of farmed fish grew at extremely rapid rates, such that the consumption of farmed fish in 2013 approximately equaled that of wild fish (see Figure 19-8). At the same time, the international index for fish prices (wild plus farmed fish) doubled from 2002 to 2014 (see Figure 19-9), making investment in fish farming quite attractive. As a result, in 2013 the industry produced $144 billion of salmon, shrimp and other seafood.



Worldwide Consumption of Farmed Fish
as Percent of Total Fish Consumption
(1961-2014)

Source: United Nations Food and Agriculture Organization, quoted in "Unchartered Waters", *Financial Times*, November 21, 2014.



Source: Price Index, United Nations, Food and Agriculture Organization, Rome, 2014, quoted in "Unchartered Waters", *Financial Times*, November 21, 2014

Consumption of farmed fish by 2013 was greatest for shrimp, salmon and trout, cephalopods (octopus, squid and cuttlefish) tuna, and groundfish (cod, haddock, and pollock) (see Table 19-1). Fully 56% of global shrimp consumption comes from fish farms mostly in Southeast Asia. 99% of Atlantic salmon consumed in 2013 from fish farms.

<table>
<tr><td colspan="2">Table 19-1
Consumption of Farmed Fish,
Selected Species 2013</td></tr>
<tr><td></td><td>Total Value in U.S. million</td></tr>
</table>

Table 19-1
Consumption of Farmed Fish,
Selected Species 2013

Shrimp	$19,400
Salmon, Trout	15,300
Cephalopods	4,000
Tuna	132
Groundfish	38

The shift to farmed fish has helped reduce depletion of the world natural fisheries. However, there is no guarantee that the farmed fish industry will continue to grow. This type of high-intensity farming can involve substantial water pollution (from fish feces and other sources). Moreover, high intensity farming of fish has been accompanied by the spread of diseases, such as early mortality syndrome in shrimp farming. This disease has recently killed a third of Thailand’s production, and has spread not only to nearby Malaysia, Vietnam and China, but to Mexico as well. Farmed salmon also has proven susceptible to disease, both in Chile and the U.S., and there are fears that accidental releases from fish farms will spread disease to wild salmon.

If the threats from environmental and disease issues involved in fish farming can be resolved, the industry will not only be able to provide a more stable, sustainable supply of fish for a growing worldwide population, it will also sharply reduce stress on natural fisheries everywhere. But, in the words of former Chinese premier Chou En-Lai, it is still too early to tell whether this will be the case.

Freshwater Fisheries: Is sustainable freshwater fishing attainable?

The preceding discussion has focused upon salt-water fisheries. But, there are increasingly serious problems facing sustainability of fresh water fisheries. The problem is of course inextricably related to unsustainable utilization of fresh water. This is an example of another of these ecological/economic inter-relationships that policy makers, social scientists and scientist rarely ever notice.

Unsustainable use of fresh-water fisheries around the world has become serious enough to threaten inland fisheries that are especially important in poor countries. These fisheries supply fish and therefore protein in diets of poor people.

In emerging nations, consider a list of rivers whose waters no longer reach the ocean. These include the Indus (India), Yellow River (China), and several rivers in Java, Indonesia. In rich nations, rivers that dry up before reaching the sea include the Rio Grande (Texas), Colorado River (Colorado/Arizona), and Murray/Pearl Rivers in Australia.

As it happens, all of these rivers are extremely important in supplying water for grain and cattle agriculture which make very heavy use of water, as we have seen. To review:

- To grow 1kg wheat requires 1,000 liters water
- To produce a kilo of beef requires at least 12,000 liters of water

In many emerging nations, the rate of decline of freshwater fishing has reached disturbing proportions. According to the World Wildlife Fund (WWF), since 1970 fish stocks in freshwater lakes and rivers have declined 30%.

Societies rightly worry about ecosystem loss and biodiversity loss in the jungle (see Chapter___). But the 30% drop in freshwater fish stocks represents a drop in biodiversity that exceeds that of animal losses in jungle and temperate forests in past 40 years. A principal reason in emerging nations has been the draining of wetlands for agriculture and commercial development. Half of the world’s wetlands were drained in 20th century. Remedies require enforceable regulations. Such regulations have worked reasonably well in Alaska and the lower 48 States, but have largely failed in Africa (Lake Victoria) and other poor nations.

Here we make use of one of Winston Churchill's many famous quotes:

"The hedgehog knows one thing very well. But the fox knows many things well".

Now yet another illustration of inter-dependency in economic issues. Fisheries and other natural resource issues clearly show the need in economics for more foxes and fewer hedgehogs, or at least hybrid "hedgefoxes", equipped to understand economic issues closely related to ecological ones.

Earth, Air, Fire and Water: Multiple Natural Resource Issues in Multiple Dimensions

The Mekong River

20th century economists, not to mention other social scientists and many natural scientists, rarely recognized and understood critical interactions between major societal issues and problems, even when they may have understood how each of these problems individually could overlap many nations at once.

Such is the case with the Mekong River in Southeast Asia. Here we find sustainability problems and potential solutions interacting to a remarkable degree along the 3,600 miles of the river. Serious water issues are of course involved. To complicate matters, there are 7 nations along the 313,000 square miles drainage area of the Mekong, which begins in South China and goes through Myanmar, Laos, Cambodia, Vietnam, boarders Thailand and ends up flowing through Vietnam into the South China Sea.

Improbably, the formerly hermit Kingdom of Myanmar (formerly Burma) was the first (in 2012) to seriously challenge the threat to the Mekong's water, forest and fisheries caused by plans for over 30 dams for hydropower along the Mekong, including 3 very large Chinese-financed dams. The search for alternative energy (hydropower) threatens to have ominous impact on fisheries in Southeast Asia.

Of the world's rivers only the Amazon has more species of fish than the Mekong. No one really knows what the impact of three dams on Mekong might have on fisheries. The country most at risk from planned Chinese dams along the Mekong is Cambodia and the resource most endangered is fish. This is a serious matter, considering that 70% of the protein intake by Cambodians comes from fish caught in the Mekong and its great lake.

In 2014 some dams on the Mekong appear to be going ahead. Will all planned dams be built? Vietnam strongly opposes the largest dam (Vietnam will be far downstream of the dam). And Myanmar is now speaking out, but Cambodia and Laos have not opposed the dams, perhaps owing to China's political influences in these nations.

Possible Solutions to Freshwater Fish Problems

Freshwater fisheries in China, Vietnam, Laos, Peru, and Sub-Saharan Africa- are most at risk. This is one reason why all countries must be very, very selective about hydroelectric dam projects on rivers that are important sources of protein.

Any solution to the kinds of problems facing the Mekong will require tight regulations and what is even more difficult, coordination of regulation across seven nations. Can regulation work under these circumstances? It has worked in the Alaska Halibut fishery, the Iceland fishery and the New Zealand fishery. But the outlook for effective regulation on the Mekong River or Lake Victoria in Africa is not good.

The reasons are traceable to Institutional problems, especially weak governance, corruption and rent-seeking activities of the kinds considered in chapter ___.

Consider how the Alaskan system has operated both in salt and fresh water (rivers).

Alaska commercial fisheries are the most productive and valuable in the U.S., with a value of over $3 billion including Halibut, Salmon and Herring. When combined with sport fishing, the industry contributes an estimated $7.4 billion and nearly 90,000 full-time equivalent jobs to the Alaskan economy. In 2010, Alaska produced 53% of the fish harvested in the United States[footnote]. This is the leading fishing state in the U.S. in one of the largest fishing nations worldwide. According to the FAO, the USA had the 4th highest catch in 2007. Alaska introduced ITQs in the late 20th century. How relevant to the Alaska experience for emerging nations fisheries? Between 1980 and 1995, the Alaska Halibut fisheries experienced severe strain, as the number of fishing vessels expanded rapidly.
“Alaska Economic Trends”, Alaska Department of Labor, November 11, Vol. 31(11), p.3.

There was no ITQ initially. There was a 100 day tightly enforced fishing season for halibut. But competition increased so drastically that there was a classic: “race to fish” situation: catch everything while you can. This did not achieve the desired result. So in response the halibut season was reduced, progressively, all the way down to 2 days in 1992.

Imagine 400 boats at anchor in the small harbor of the City of King Salmon – ready to put to sea. This led to the most intensive fishing one could ever observe – boats battling each other for the catch and a sharp rise in fishing deaths.

So, Alaska implemented a variant of an ITQ system in 1995.

As elsewhere, the authorities

1. Determined the TAC
2. Provided quotas to each boat owner
3. Total quotas awarded added up to the TAC, for each year
4. Quotas were awarded free of charges (a mistake, hopefully to be corrected)

5. Each owner’s quota was converted into an ITQ, showing his share of the total
6. No boat captain or firm was allowed to hold more than 1.5% of the total TAC

How successful has the Alaskan system been?

After a couple of years of missteps, it has been so successful that:

1. The halibut season has even been extended substantially
2. Prices for Halibut have climbed, for 2 reasons

    - Fewer Halibut are now caught
    - Now, more halibut can be sold as fresh fish, which attracts a 25% premium over frozen halibut. Under the old system, one caught as much as one could, but froze most in order to not flood the market at any given time

3. The size of the fishing fleet has halved, from 3,000 to 1,500. There are lessons for other countries from the experience of Iceland and Alaska.

But even where ITQS can be successfully implemented that is probably not enough to forestall threats that may lead to fishing collapses, especially in poorer nations.

Other measures must also be taken: *One important measure:* End subsidies to fishing.

As noted in chapter ___, many emerging nations (Nigeria, Venezuela, and Indonesia, among many others) heavily subsidize diesel fuel. EU nations subsidize diesel fuel used by fishermen. A very large share (25-30%) of fishing costs is for fuel. And in a few nations, total subsidies to diesel fuel used in fishing boats exceed the actual value of the catch.

A second measure: Prohibit or regulate the discard of “by-catch. Example: In fishing for Tuna boats board a lot of fish of other species that are not as valuable. Most by-catch in most of the world is dumped overboard. Usually the fish are dead or soon will be. By-catch in many nations constitutes 25% of total catch. This is clearly a needless waste of valuable resource.

Regulations are required here; regulations that specify that all by-catch be kept and brought back to port. (By-catch needs to be reported as part of any ITQ). This may seem unreasonable. Suppose the by-catch is the decidedly untasty fish called "Irish Lord." If the by-catch is not fit to eat, it can be sold for fishmeal and fertilizer. There are good markets for these products.

Trawlers with dragnets are the worst offenders regarding by-catch. The severity of the by-catch problem differs by species and region.

Consider what happens in halibut fishing. A very valuable fish. In 2013 fresh Halibut sold for $22 lb or more at Whole Foods. Generally the Halibut fisheries in Alaska are well regulated. The problem lies in areas outside the designated Halibut fisheries. Salmon trawlers in the Gulf of Alaska are allowed to take 4.4 million lbs. of Halibut as by-catch.

But, there are about 14 million pounds of halibut by-catch in non-halibut fisheries (fisheries beyond the zones of regulation). In other words halibut catch outside of the halibut fisheries is about 3 times that of the regulated fishery. A sustainable fish stock cannot be maintained that way.

As we noted, by-catch waste constitutes needless waste. By-catch discards account for about 300 million tons or (20-25%) of total world catch. [footnote] Such large figures signal that by-catch represents both a significant biological and economic loss to fisheries everywhere. Successful ITQ systems in New Zealand, Iceland and Alaska closely regulate by-catch within commercial fisheries, by requiring that by-catch be a part of the quota owner's catch for the year. In New Zealand and Iceland in particular, discarding by-catch was deemed a serious violation of the rules of the ITQ system. There, fishermen exceeding their limit due to by-catch have to either pay a fine or buy up someone else's ITQ. Alaska also significantly ameliorated the threat to its fisheries by allowing sablefish fisherman outside of Alaska's economic zone to hold both halibut and sablefish quotas. This considerably decreased the discarding of halibut. With conventional licenses and weaker types of regulation, the problem of by-catch discards is pervasive across commercial fisheries. By implementing

by-catch regulations. ITQ system can further contribute greatly to more sustainable fisheries.
David Witherell et al., “An Ecosystem-based approach for Alaska groundfish fisheries”, ICES Journal of Marine Science, 2000, Vol.57, p.772.

Other very destructive fishing practices will need to be curbed if fishery resources are to be sensibly conserved. Illegal nets, such as purse seine nets that drag the bottom are used often in tuna fishing. Some of these purse-seine nets are up to one mile long. Heavy damage to the sea (floor) also results. Another destructive fishing practice is use of extremely long-line fishing. In some cases these nets are many kilometers long, with tens of thousands of hooks. Worldwide, long lines kill 400,000 dolphins (porpoises) year.

Trawling for fish has become a significant issue in Europe. The European Parliament has been trying to phase out deep-sea trawling. Bottom gill-netting is an especially serious issue in France and Spain, where by-catch has been 20%-40% of the total. Bottom gill-netting also involves serious damage to the sea floor. So far efforts to restrain this practice have gone nowhere in Europe.

Finally, sustainable fisheries can be promoted by prohibiting, or closing fishing during spawning season (Iceland had 180 such enclosures in 2009).

The Spread of ITQs

There are an increasing number of countries moving to various versions of ITQs. In Europe Britain, Iceland, Denmark, Netherlands and Spain use them. This has already led to smaller fishing fleets in those nations.

An EU “Green paper” issued April in 2008 states that all EU countries should issue ITQs and that these rights should be tradable between national fishing fleets. This is a true market-oriented reform.

Emerging nations would do well to consider- ITQs tradable between different national fishing fleets. There are, however, problems administering the ITQs (as we see below).

Still, the spread of ITQs has a long way to go. Thus far of the worlds 10,000 fisheries, only 121 are using ITQs. It is not easy to allocate catch shares. Enforcement is not easy. Developing a good ITQ system sometimes takes 5-10 years, but if the world in emerging nations does not move toward ITQs future generations will not eat much fish. But, ITQs are necessary but notsufficient as tools to protect fisheries.

Other Sensible Regulations

There are two kinds

1. Ancient methods
2. New forms - modern methods

1. *Ancient Methods*

   Millennium ago, salmon fishing in Scotland was all from riverbanks. The first known regulation of fisheries was that decreed in Scotland salmon fishing a thousand years ago (1040) by Malcolm II, King of Scotland. (Malcolm was also the King who surrendered to William the Conqueror). Later King Alexander of Scotland strengthened Malcolm's regulations in 1150.

   Malcolm II later imposed a limited season on fishing for Atlantic salmon. This prohibited Scotsmen from fishing until several weeks after the beginning of the annual salmon run, so as to allow enough breeding stock to go upstream and lay eggs and fertilize them. Salmon are born in freshwater and later young fish head for the ocean. Mature adults return to their birthplace to spawn. The regulation was strongly enforced.

   900 years later (1909) in Alaska canneries set up at mouth of Yukon River took almost all the salmon headed up river. As a result Eskimos and Athabascan upstream were starving. This was stopped by an Episcopal Deacon called Hudson Stuck, who convinced the U.S. Congress to pass a law prohibiting unchecked fishing at the mouth of the Yukon.

2. *New Forms*

Now there are new forms of traditional regulations shown to be useful in U.S. Gulf Coast. The question is how transferable to emerging nations are the lessons learned from Gulf Coast and Caribbean?

Consider how fishery protection measures used in the West can be utilized in emerging nations. The major issue is lack of intangible capital available to governments that would enforce fishing regulations (see Chapter __): administrative skills and enforcement techniques are lacking. This cannot be easily overcome without higher compensation to relevant officers.

This represents a promising area for foreign aid to finance training and equipment in emerging nations to enforce fishing regulations (see Chapter ___).

At present, these new approaches to overfishing can be administered fairly well in the richer nations. With exceptions, not so well in poorer emerging countries. In developed nations, technology has been increasingly used to enforce ITQs. GPSs (global positioning systems) are now placed on boats so that satellite monitoring is possible at all times. Also, governments in rich nations consult websites where they can keep current on all landings, by date and by species. This also helps fishermen. Why? They can also consult websites to decide:

1. Whether to sell the catch fresh, or to freeze it
2. Whether to buy or sell ITQs this week or next month

This approach could also work in Thailand, Indonesia, and Vietnam. However the technology is expensive and trained inspectors of boats are few and far between in poor nations. Again a very good foreign aid project would be to furnish equipment and technology for fishing regulation in poorer nations.

Newer and affordable technology is required to curb illegal fishing, estimated to be $23 billion worldwide from:

1. Catching more fish than allowed
2. Catching fish from areas closed to fishing to permit recovery of fisheries
3. Mislabeling fish caught

There are new tools available to limit these problems. This tool uses genetics to determine where fish are caught, and which particular local population (fishery) it came from. Such a system is already in use in Denmark.[footnote]
“To Fight Illegal Fishing, Forensic DNA Gets Local”, *Science*, December 10, 2010, p.1468.

Illegal ocean fishing will likely soon be sharply curbed in America and European and New Zealand fisheries using new technologies such as SNPs (single-nucleotide polymorphisms). SNPs are Specific Nucleotides in a DNA sequence that varies according to fish species and varies according to spawning grounds. This is a genetic test, could be used by poor emerging nations, but for 2 issues”

1. Cost of enforcement
2. Corruption in enforcement

In most emerging nations where fishing is restricted, owing to ITQs, or banned, it is relatively easy for boats to slip undetected in and out of these areas to take illegal fish, either because of faulty enforcement or corruption of enforcement officials. New technologies promise to rectify this problem. Google has developed a free tool that allows anyone with an internet connection to identify and, if need be, board illegal fishers. The device is called the Google “Fishing Watch Tool”. The tool uses satellites to capture signals from automatic tracking devices required today for all large ships, so as to avoid collisions at sea.[footnote] The free software rapidly analyzes massive amounts of data with the help of a behavioral algorithm that enables enforcement officials to determine where a boat is located, how fast it is moving and whether it stops or moves slowly in order to commence fishing. Google plans to roll out a website for free public use before 2017.
“Google Joins Fight against Illegal Fishing with Free Tracker Tool”, *Financial Times*, November 14, 2014.

It is expected that this new, free tool will enable sharp reductions on illegal fishing now totaling about 26 million metric tons per year.

GENERAL INTRODUCTION TO SAVINGS MOBILIZATION

The next few chapters are mainly about financing economic growth and economic development. Where do you get the resources to pay for government spending on Human Capital, especially primary and secondary education? How do the public and private sectors find the resources to invest in Human Capital, or in physical capital (such as new factories) or natural capital. Do you get the resources domestically? Or can you fund foreign sources aid or foreign direct investments.

So, now we may consider Saving Mobilization.

First- mobilization savings through the public sector (taxes). Then mobilization of savings, through domestic private sector (households and corporations). Then mobilization savings from foreigners.

Overall Introduction to Savings

How has savings trended in rich countries in past four decades? (Need this as perspective for understanding LDC savings trends).

First though, let us understand a truly fundamental point, never forget it, how does a society best provide for interests of future generations? Answer: leave future generations a larger capital stock then was bequeathed to present generations, without ruining the environment in the process.

Capital Stock – both physical and human capital and natural capital stock resources economics. There is only one good way to finance a larger capital stock. Savings, whether private or public, foreign or domestic (we will see that sometimes nations resort to inflation to finance. Rising savings rates reflect societal preferences for improving welfare of future generations.

Falling saving rates reflect the opposite: a lower societal preference for improving welfare of future generations.

Finally saving rates are bad enough in rich countries, but in poor countries falling saving rates would mean they would never catch up to rich ones.

In fact net national savings rates in rich nations have declined very sharply since 1970 until 2008.

	1970	**1980**	**1990**	**2000**	**2006**
U.S.	9.5	8.6	4.8	6.8	2.1
France	17.3	11.2	9.7	10.5	6.6
Italy	17.4	12.7	8.3	7.1	4.2
Japan	30.5	20.7	20.4	9.6	7.8
Spain	15.9	9.2	10.9	10.1	7.6
Germany	19.7	9.5	12.8	6.2	9.8
U.K.	14.0	5.7	3.6	4.2	4.5
Canada	12.0	12.3	6.2	12.7	12.5

NET SAVINGS: National Savings Rate for Selected Years (as % of GDP)Source: World Economic Outlook Database, Washington, DC: International Monetary Fund, April 2007
Note: Net savings = Gross savings minus depreciation.

Note Canada as outlier. Explanation? Unclear.

Since 1970, there have been very sharp declines in the saving rates in U.S. and Italy. Japan used to have high rate, Japan rate now ¼ that of 1970, so is U.S. and Italy.

What is going on?

Role of demographic factors – rapidly aging societies may help explain declines in Japan and Europe: There, stagnant population growth, aging leads to more current support for older people probably mean less support for future generations. But that does not explain the U.S. savings decline since the U.S. population still relatively young compared to Japan and Europe.

Is this bad news? Yes. However, CAVEAT emptor, always be careful interpreting such figures.

There is “some” good news imbedded in these figures.

These figures include not only domestic private savings, government savings (or dissavings) since most societies have been running deficits (U.S., Japan, virtually all of Europe) the savings rates in Table 20-1 includes all government sector deficits. Now, a large portion of government deficits does represent dissaving. (% GDP U.S. deficit 2008 – 7% U.S. deficit 2009 – 10% GDP 2012 – 13%)?

But not all the somewhat good news: to the extent that a government deficit is incurred to finance capital formation we worry less about low natural savings rates. Why is that?

But consider the > $1 trillion + deficits expected for U.S. for next few years.

Perhaps $100 billion year may reflect $ spent on roads, harbors, education, community, research, etc. These are all investment items. That is the good news, but the good news is unfortunately swamped by the bad news. Dramatic drops in national savings rates and rising government deficits bode ill for welfare of future generations.

LCDs

By way of contrast: savings rates in the fastest growing poor nations have been very high, and have drastically increased in India and China since 1980s.

India	1990	23%
	2002	25%
	2007	36%
China	2006	50.4%

Gross Savings Rate

Net Savings = Gross Savings – Depreciation

India – 23%
China – 40%

It is apparent that different countries display different degrees of reliance on private savings mobilization efforts. And some countries rely more heavily on certain forms of private savings then do others.

Net savings in developed nations are indicator of savings available for both domestic and foreign uses.

We have noted the behavior of total net savings in **rich** countries over the past 20 years.

1964 net savings almost 11% GDP, rose to 14.1% by 1973. Fell sharply after 1973. Why? First oil crisis. Rose again by 1979 to almost 11.0%, fell again to 8.8% in 1981. Why? 2nd oil shock – In U.S., net household S reportedly approached zero.

Net savings in U.S. = 1.2% of GDP

Government Savings – before 1973, government savings were about 20% of total net savings in developed countries.

Since 1973 government savings has been negligible. It has even been negative in some years, except in the outlier, Japan.

Elements of Private Savings

First- Corporate Savings (retained earnings). Definition: after tax profits minus dividend payouts. Before 1973, corporate savings tended to be about 25-30% total savings.

Industrial Nations- since 1973, corporate savings rates have been highly erratic. Almost nothing in some years, about 20% in total savings in other years.

Household Savings

Since 1973, household savings has been by far the chief source of savings in rich countries – except U.S.

Government and corporations dissaved in 1975. Since 1975, household savings has accounted for more than 70% of total savings in rich countries.

What about emerging nations? Examine the most recent year for which data available. Examine gross savings (figures on net savings are not reliable for poor nations).

Look only at domestic savings for now. We examine foreign savings later.

In low income emerging nations e.g. India, Pakistan, private sector savings, household and corporate savings were over 80% of total savings. Government savings in emerging nations usually negative and never more than 5-6% total savings,

In lower middle income countries private sector savings constitute 75% of the total.

For upper middle income countries (e.g. Korea, Malaysia, Brazil) private sector savings is well over 90% of total domestic savings.

We can see that for most of the world, private savings are by far the principal source of domestic investment finance.

When we later add foreign private savings, we will see that private savings are overwhelmingly the source of investment finance around the world, since most foreign savings flowing to emerging nations are private saving, not foreign aid.

CAVEAT: There is more to the story. Canada as outlier – rate went up.

Chinese savings rates discussed next week.

Role of demographic factors? May be very difficult for U.S. vs. EC or Japan.

A Special Case: Saving in China

The Chinese experience since 1980 is so distinctive – and so important for world savings – that we will delve more deeply into Chinese savings than will be the case for other nations. So high were savings in China that by 2011 the Chinese government had actually begun to encourage households to save less, and consume more, so high are their savings propensities.

Eleven Reasons Why the National Savings Rate in China has been so high (since 1980)

1. Chinese savings are high because Chinese income has been growing so rapidly - circa 10% per annum. (This mirrors Japan's experience 1950-1990.) (Before the decade-long Japanese recession).

2. Chinese families stress savings because the benefits offered by the governments' social security system are so small (less than $200 per capita total – not per month but per year).

3. No More "Iron Rice Bowl"
Mao Tse-Tsung habitually spoke with great pride of the Communist party's "Iron Rice Bowl"A full bowl of rice for every meal for all families – This was said (by MAO) to be a cradle to grave – guarantee of sufficient food (esp. rice, shelter, etc) to be paid to all citizens whether employed or not.

There is no more Iron Rice Bowl. So citizens must put aside a large buffer of savings in case they become unemployed.

4. Chinese families now need a buffer of savings to finance health care, since provision of public health services is very limited, especially in rural areas. Note: many Chinese villagers lack health clinics, but many of them have sonar machines.

5. To an extent not common elsewhere (except perhaps Vietnam) do Chinese families strongly value good primary and secondary education for their children (actually, their child, not plural- one per family).

Public schools do not meet expectations of millions of Chinese families, so these families stress savings in order to finance private school for children.

6. The Savings Rate and the one-child-per family policy: The demographic consequences of this policy have – as you would expect – increased the need for savings for old age. Why? Fewer children to support people who have reached old age.

7. Difficulties facing Household Borrowing: Families in North America, Europe and Japan undertake substantial borrowing to finance purchases of homes, to finance purchases of appliances, etc.

The Chinese financial markets for household borrowing are still largely undeveloped. So, these purchases require prior savings.

8. Rural Workers and Farmers
Legal restrictions on migrant Rural Workers make urban employment precarious for many. This heightens economic insecurity. Also rural farmers receive very limited public health and education services from government, hence the need to save to deal with uncertain, highly variable income. It is not just low income that is making savings difficult, it is highly variable income.

9. Confucian Influence? (on Households)
Confucian Savers in not only China, Hong Kong, Singapore tend strongly

to save more than other groups (savings targets for families are typically one-fourth to one-third of income).

10. State-owned Enterprises (SOE^{s})
China's industrial structure is still dominated by government owned firms (– State Enterprises or State corporations.) It is not at all uncommon for Chinese SOEs to have very high retained earnings (Corporate Savings). In fact, about 25% of total savings in China comes from retained earnings of Corporations, especially SOE^{s}. Why?

a. Retained earnings are naturally higher in China because typically Chinese SOE^{s} do not pay dividends, being State-owned, and until recently paid few taxes.
b. Western firms, in the U.S. and Europe face greater pressure to pay dividends, because of pressure for returns from private sector stockholders.

11. Marriage Prospects. Chinese urban families expect that male suitors will own a house or apartment. These are very expensive in urban areas. Whole families save to finance apartments for male suitors. Especially serious, given ever-growing shortage of brides because of one-child per family, strong son preference, and still common abortion of female fetuses.

Methods for Savings Mobilization

A major emphasis in fiscal policy in emerging nations over last 50 years has been attempts to use the government budget to mobilize government savings for finance of investments, both public and private investments. This of course requires governments to have budgets wherein taxes exceed current consumption expenditure of government. But government saving can be only part of the savings mobilization story. It is important to put government savings in perspective with other savings sources, domestic and foreign, public and private.

To a certain extent, the different sources of savings are substitutes – Policy may choose to emphasize domestic rather than foreign saving, private rather than public savings, etc. A decision to rely more heavily on one source of saving is usually a decision to rely less heavily on another.

For example, a decision to emphasize public (government) savings is usually a decision to deemphasize the role of foreign savings stress on domestic private savings as a source of investment finance is a decision to stress monetary policy over fiscal policy, as you will see.

To understand resource mobilization issues, first need to develop a simple, workable taxonomy of savings. (Please see Table 20-1).

Some Identities

Savings Mobilization: General Consideration

A. Taxonomy of Savings

For the economy as a whole, in any given year, ex post.

1. $I=S$
   Both investment and savings consist of a number of elements
2. $I=I_G+I_{PD}+T_{PF}$
   I breaks down as follows:
   I_G = Government Investments
   I_{PD} = Domestic Private I
   I_{PF} – Foreign Private I
3. $S = S_D = S_F$
   S_D = Domestic Savings
   S_F = Foreign Savings
   But both S_D and S_F may be broken down as follows in (4) and (5)
4. $S_D = S_G+S_P$ (DOMESTIC)
   S_G = Government Saving
   S_P = Private Saving
5. $S_F = S_{FO}+S_{FP}$ (FOREIGN), to be discussed in due course
   S_{FO} = Official Foreign Savings (Foreign Aid)
   S_{FP} = Private Foreign Savings (Direct Investment Plus Debt)
   Note also, (Private S) S_P can be broken down still further as in

6. $S_P = S_{PC}+S_{PH}$
   S_{PH} = Household Savings (DOMESTIC)
   S_{PC} = Corporate Savings (DOMESTIC)
   Not include foreign corporate savings
   S_G can be broken down further into two components, as in (7)
7. $S_G = S_{GB}+S_{GE}$
   S_{GB} = Budget Savings
   S_{GE} = Savings of Government-Owned Enterprise
   (i.e. Mining, textiles, electric, water, etc., etc.)
   (i.e. profits of SOE^s – almost always zero or negative, except in oil companies)
   S_{GB} is defined as:
8. $S_{GB} = T-C_G$ (BUDGET SAVINGS)
   T = Government Tax Revenue (current receipts)
   C_G = Government Consumption Expenditure

   To Recapitulate:
9. $S = (S_{GB} + S_{GE}) + (S_{PC} + S_{PH}) + (S_{FO} + S_{FP})$

What is government consumption? All current government expenditure plus all capital outlays for military spending. So, current government expenditure consists of

1. Salaries- civil servants and military
2. Government supplies – paper, paper clips, electricity
3. Maintenance of public sector K – repair bridges and upkeep of bridges, roads (expensive)
4. Subsidies – water, pesticides, gasoline (subsidies are often 30-50% of budget)
5. Interest on public debt (government debt)

Interest on public debt – This is what countries pay to service past deficits.

Interest on the public debt constitutes a major share of the budget in many emerging nations (see Table 12-2 in text).

Very high (21-27%) in India, Zimbabwe, Greece.

15% in Brazil in some decades.

Note – interest as a % of public debt is higher in U.S. than in Korea, Germany etc. In future is going to be much higher in U.S. Why?

When international or public debt goes above 10% it starts really crowding out other government expenditures. Why? Because this interest must be paid. Is a contractual obligation. You can cut other government C but you cannot cut interest without repudietry debt.

U.S. in next decade with budget deficit going to 13-14% GDP then interest payments on debt will soon have to rise to 15-16% of the federal budget.

There will be much less room for discretionary government spending in the U.S. (spending on education, research, defense etc.).

In any case, important to understand that the relative emphasis placed on different sources of savings vary greatly across nations, both for reasons of ideology as well as opportunism.

Now, consider identity #7, which defines government savings: government savings are two types – G_B Government Budget Savings requires an excess of tax collection over government current expenditure. We will spend considerable time on the quest for government budget savings.

The other part of government savings is the savings of government owned enterprises (SGE).

We saw in Chapter ___ that government owned enterprises are present in all emerging nations. Call them all SOE^s state-owned enterprises.

In some countries (China, Iran) the SOE sector is bigger than the private-business sector. More than ¾ of all Chinese firms are SOE^s. In Russia, SOE^s are 62% of total firm – Brazil – 38% (500 SOE^s). China still has a big round of privatization from 1985-2005, still has 468,000 SOE^s. Some were huge. Three of the world’s 10 largest firms are SOE^s.

And ------ All three are Chinese (Sinopec, China National Petroleum and CNOC China National Oil Co.) other nations with big SOE sectors include: Brazil, Russia, Indonesia, Zambia, Ecuador, Venezuela, India, Pakistan etc.

SOE^s are found in almost every sector- oil and gas (Petrobras) and hard minerals. (P.T. Timal) (Combibol XXX)

Banking and finance, construction, electrical power, pawn shops, you name it.

In early models of socialism, as for example that of Poland's Osker Lange in 1940, SOE savings were supposed to provide much of the total savings needed for investment in emerging nations.

How has this worked out?

Not so well, although some SOE^s are well managed and do make profits that count as government savings.

Example
Petrobras (Brazil)
Vale (Brazil)
Petrobras (Malaysia)-oil
Ecopetrol (Columbia) –oil -----guessed at name and country
Statoil (Norway) – oil

Unfortunately, these natural resource firms are exceptions to the given rule that SOE^s account for a negligible proportion of governments savings across the world (except in oil and gas, where it is very difficult to have an excess of expenses over revenues.

If you look at the NI accounts of countries, you will generally find that government savings through SOE^s tend to be either negative or insignificant, except in the big oil explorers.

China and India both report that SOE^s in their countries had positive savings.

Chinese report that for their 468,000 SOE^s, the rate of return or the government equity invested in them is 4% (however, note that all Chinese SOE^s get ample and subsidized credit from Chinese SOE^s in banking.

India has 217 SOE^s owned by central government and 850 SOE^s owned by regional government.

Some of the Indian SOE^s owned by central government made huge losses in 2010.

Air India losses and MTNL (Tekon) were in excess of $2 Billion U.S. Even so, India government maintains that rate of returns on equity in their SOE^s is 14-15%?

Take away from this – One should not count on generating much public savings through SOE^s unless they are large oil exporters.

That means that in the search for more government savings, need to find ways to insure that tax collection greater than government current spending.

History – In fifties, sixties and early seventies, the typical development strategy was reliance on government savings to finance investments, both public and private investments.

Why?

Because, it was argued, growth in private savings in emerging nations is inevitably constrained by law per capita income as well as higher consumption properties especially among the few wealthy families (cite: En vez de la miseria by Jorge Ahumada, Publisher: Santiago de Chile, Editorial del Pacífico [1958], found in Fondren Library).

And, because many LDC^s discouraged foreign private savings in this era and because official foreign savings (foreign aid) was not unlimited, it was argued that only government savings could bear the burden of investment finance.

One possible way to mobilize government savings reduce government consumption

But government consumption is very "sticky downward": few governments are willing to take political risks of cutting say subsidies to energy and food. In some cases this would be inadvisable anyway – often reducing subsidies produces riots.

So, most feasible way to Increase Governments Savings? Conventional Wisdom: Raise Tax-Receipts.

i.e. Raise the ratio of tax collections to GDP.

How? By tax reform, if possible, and by tax rate increases or new taxes, if not.

KEYPOINT: This view of appropriate savings mobilization bias was based on the view that mps out of an additional dollars worth of income was significantly lower in the private sector then public sector. So, by shifting income to government, you could raise overall savings rates.

Promoting this view became official policy of virtually all foreign aid donors, including U.S. – "No aid for you unless you increase tax collections," i.e. "We will help you if you help yourselves."

So countries willing to install higher domestic taxes on L&K were seen as more "deserving" of foreign aid.

Indicators of "deservedness" included high tax "ratios" – high rates of tax as % GDP.

But again this whole strategy depended on the appropriateness of the assumption

MPS_G Public Sector > MPS_P Private Sector

We will come back to this.

What would be reasonable tax rates for poorer nations?

Before the 1980s for the rich countries, tax rates exceeded 45% or even 50%. (Show U.S. rates). Now tax in rich nations but we would of course not $x \leq 30\%$.

But we would of course not expect CDC^s ever to have tax ratios nearly as high as rich nations. Why?

First – lower per capita Y allows a much smaller margin for taxation after subsistence needs met. i.e. poor countries have much lower taxable capacity.

Average tax ratios, less than 10% for very low income nations, 20% for middle income, 28% average for wealthy nations.[footnote]
See Gillis, Perkins, Snodgrass, Economics of Development, 5th Edition

But in very poor countries, the majority of taxes are taxes on international trade. Why? (Tax handles).

We now look more closely at this set of issues.

Now, constraints on taxable capacity and tax effort.

Remember higher taxes can lead to higher overall savings, but only if the governments MPC out of increased tax collection is smaller than the private sectors marginal propensity to consume out of the taxes it pays.

Is this ever so? Yes there are examples from history, but except China, there are few from recent history. Consider Japan after the Meiji Restoration in 1880s. Larger government savings were generated through government budget surplus. These surpluses played a major role in Japanese economic development 1882-1930. The Japanese government displayed these government savings for major investments in physical and human capital, and also quite a bit of military hardware.

But other stories of success in mobilizing savings through the government budget are hard to find. There are examples of limited histories of success in a few oil producers, such as Indonesia from 1970-1982, where oil revenues fed government surpluses that were plowed into primary and secondary education and infrastructures. But that wasn’t easy (budget category A-a).

The usual pattern is that the government’s MPS out of increased taxes is sufficiently low that increased taxation led to less, not more overall savings. Why?

Consider World Bank or U.N. data for 150-175 nations over this past 40 years, you will find that governments exhibit a higher MPC, not a high MPS.[footnote]
Need reference

While tax ratios-ratios of tax collection to GDP – rose some over the 60s, 70s, and 80s, public sector consumption expenditures expanded at even faster rates then did tax collections. And outside of oil, gas, copper etc., where there are high natural resource incomes (rents) savings of government-owned firms were typically negative too.

So, there are two reasons why public savings through the budget declined steadily for most poor nations over past 40 years

1. Inefficient SOE^{s} that generate little or no savings (except in oil), and except in China 1985-2014.
2. Rapid growth or government consumption expenditures in many nations

This experience was not confined to just a few countries: in over 50 developing countries, the public consumption share was as high or higher in 2000 than in 1960, even after nearly four decades of intensive efforts to mobilize savings through the budget.

Again, please do not think that government C is necessarily undesirable. In fact, in many poor nations growth in government C has been due to government efforts to hire and keep qualified civil servants and public C is essential to maintain the public sector K stock – roads, schools, harbors.

But sometimes higher government consumption has been due to rapid build-up of military purchases or waste in government procurement of materials, or to upkeep of a government vehicle fleet dominated by Mercedes or Bentleys (in Nkrumah's Ghana or Shah Pahlevi's Iran). This type of government consumption not ordinarily very helpful to development.

Taxes and Resource Mobilization

Why has it proven so difficult to increase tax ratios in LDC^s?

And why do tax ratios (T /GDP) differ so markedly across countries?

It is clear that low per capita income constrains tax collection. Note that even for countries at similar levels of income, we find vastly different ratios of T/GNP.[footnote]
Gillis, Perkins, Snodgrass, Chapter 11

What factors might be responsible?

Some hypotheses (for poorer emerging nations)

Foreign Trade

Countries with a high share of foreign trade in GDP usually have a higher tax ratio. Why?

Natural Resources

Exports – Countries who exports are primarily of oil, gas, minerals tend to have higher T/GDP.[footnote]
See Jurgen Lotz and Elliot Morss, "A Theory of Tax Level Determinants for Developing Countries," Economic Development and Cultural Change Vol. 18, #3 (April 1978); and Roy W. Bahl, "A Regression Approach to Tax Effort and Tax ratio Analysis," JMF Staff Papers Vol. 18, #4 (November 1971).

Difference in Tax Structure

We will see that countries that rely on Value Added Taxes tend to have higher tax ratios (this not from econometric evidence, but from an intensive review of African experience we will do.

Actual collection of taxes is not easy. Even in much of Western Europe outside of Scandinavia, evasion of income taxes is a fairly easy matter; and avoidance of income taxes may be the second or third most favorite outdoor sport in France, Italy, Spain or Greece.

Evasion is distinguished from avoidance of income taxes in the sense that evasion encompasses activities to conceal net income, or falsify tax deduction, whereas avoidance is merely the rearrangement of one's affairs, often with expert legal help, to minimize tax obligations. Evasion is illegal, a punishable offense; avoidance is not.

In any case a higher share of foreign trade in the economy does enhance a country's taxable capacity, or the potential yield of the tax system. But even more significant than the degree of "openness" is the relative importance of natural resources in GDP and in exports. Virtually every study on the determinants of tax ratios that poorer countries with relatively large production of oil and minerals, and consequently a high share of resources in exports, have substantially greater taxable capacity than countries at the same level of per capita income and the same degree of "openness," but with relatively small natural resource production and exports.

Countries with the highest tax ratios tend strongly to be those where natural resource exports are a large share of total exports.

Why? Two reasons

1. Large rents in natural resource extraction
2. In most countries, up to 21st century, natural resource extraction dominated by large mines – internal need for good books easy to xxx.

The poorest developing countries encounter the greatest difficulties in trying to raise share of T in GDP.

Poorest – those with T less than $800 in per capita Y (about 75 nations).

Let us look at systematic approaches that try to shed some light on the tax dilemma facing the poorest nations. What determines taxable capacity?

Dozens of formulations have been tried, using numerous exploratory variables. One of most illuminating is by Roy Bahl, who used cross section data for 63 nations and estimating equation of the following form:

$$\widehat{\frac{T}{y}} = d + B_1 (Y_p - X_p) + B_2 N_y + B_3 X^1_y$$

$$\widehat{\frac{T}{y}} = \text{predicted ratio}$$

Where 4_p = Per capita income in U.S. $

X_p = Per capita export income $, thus:

$(Y_p - X_p)$ = Per Capita Non-Export income in U.S. $ (avoid double counting of influence of openess)

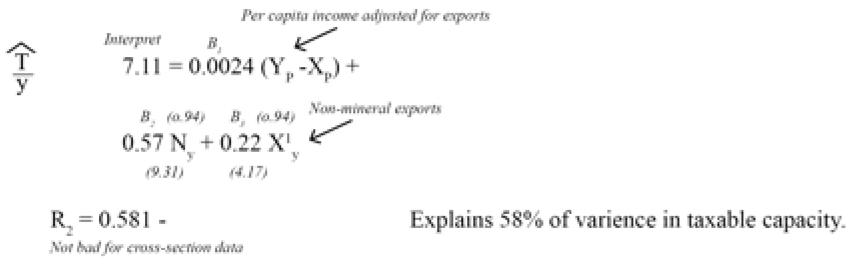
N_y = Share of mining in GDP, including petroleum

X^1_y = Ratio of non-mineral export earning to GDP

In effect: Bahl’s approach allows you to find out what you should expect the tax system of any LDC to yield if average rates for all countries applied to that countries tax base.

The results appear to confirm first, the relatively limited significance of per capita income by itself, and second the great importance of “openness” and natural resources in determining taxable capacity.

Results of Regression (cross section data)



Per capita income adjusted for exports

$$\widehat{\frac{T}{y}} \qquad \overset{\text{Interpret}}{7.11} = \overset{B_1}{0.0024}\,(Y_p - X_p) +$$

Non-mineral exports

$$\underset{(9.31)}{\overset{B_2\ (o.94)}{0.57}}\,N_y + \underset{(4.17)}{\overset{B_3\ (o.94)}{0.22}}\,X^1_y$$

$R_2 = 0.581$ -

Not bad for cross-section data

Explains 58% of varience in taxable capacity.

Except for B. all coefficients are significant at 95%

What do results mean?

(Vertical) Intercept – Sort of a minimal tax ratio

1. Per capita Income outside the export sector NOT statistically significant in explaining why some countries collect higher share of T/Y. regression says: Increase of $1.00 in non-export income per capita leads to a rise of only 0.0024 cents on preXXX tax ratio.
2. Confirms importance of natural resources sector. (N_g) in taxable capacity.

An increase of 1% of the share of mining in GNP would be expected to lead to a large increase in taxable capacity: about 0.57percentage points.

Why? The “Tax Handle Argument,” which we mentioned earlier. If the mining share in GDP is 10% in one country and only 1% in another the equation suggests we would expect ceterus parabus difference in their tax ratios of nearly almost a five percentage points.

What about variable X’y?

An increase of 1% in the share of non-mineral exports in GNP would be expected to increase a country’s tax ratio by 0.22% points. So, if Brazil has (X^1_y) of 15% and Tanzania has (X^1_y) of 5%, we would on that account alone expect tax ratio in Brazil to be 2.2% higher (0.22 x 10 percentage points) than Tanzania.

Why would we expect such a difference? Why would countries with a higher ratio of exports or imports to GDP have higher tax ratios than those where foreign trade was relatively less important? The reason as noted earlier, is that foreign trade, whether exports or imports, must normally pass through a bottleneck (port) where it can be more easily observed and quantified.

Therefore, taxes imposed upon foreign trade (import duties, export taxes) are imposed on tax bases that are relatively more accessible then income to the tax administration. Taxes on income, wealth, and even domestic consumption, are imposed on bases that are much more easily concealed from tax officials than is the case with import or export taxes. This is particularly true for income taxes. In Ghana in 70s, we found that almost 100% of personal income tax collection came from income taxes paid by civil servants. In Indonesia we reviewed all the income tax returns in the major city of Surabaya in 1982 and found that 90% of income taxes were paid by the minority Chinese community. Administration of these taxes requires administrative resources and skill levels that are in chronic short supply in developing nations.

TAXATION AND DEVELOPMENT

Worldwide evidence indicates that good tax policy can play a useful role in promoting growth and in providing resources to improve education, health and if carefully done, even income distribution. But, while sensible tax policy is critical in providing an overall policy environment for facilitating growth, not even the very best tax policy can drive growth by itself.

Consider again a fundamental point: sustained growth requires above all steady growth in productivity and therefore strong growth in Capital formation, including human, physical, intangible capital, and under some circumstances, natural capital.

Shortsighted tax policy can have very serious adverse effects on growth, by discouraging capital-formation. Thus, tax policy that impinges least on productivity favors economic growth. At the same time, there is a need to keep the tax system off the backs of the poor. For reasons and other reasons in patterns of taxation have been evolving, mostly for the better, over the past few decades.

Trends in Taxation

Worldwide, there has been a very marked shift toward consumption taxes. At the same time there has been a shift from heavy taxation based on income, especially taxes in capital income, in a world where capital is mobile internationally.

The most significant feature of these shifts, by far, has been ever growing reliance on the Value-Added Tax (VAT) across the world, with somewhat lesser reliance on income taxes, imposed at lower rates than in the first two decades after World War II. The VAT is merely an advanced type of sales tax.

The VAT idea is not even 65 years old, but it has had an astonishing record of acceptance. There has never been a fiscal revolution that happened so fast in so many nations. The VAT was first used only in France and Brazil in the 1950s. Now it is found in over 160 nations rich and poor. The VAT–

based on consumption, not income–now accounts for over 25% of all tax revenues worldwide.

Four principal reasons account for the rapid expansion in the rate of this tax in Europe, Asia, Africa and Latin America.

1. We will see that as a consumption tax, the VAT has a smaller retarding effect on capital formation that a revenue equivalent income taxes.
2. The VAT has been a proven revenue workhouse almost everywhere it has been adopted.
3. The VAT has fewer adverse effects, relative to income taxes on key incentives to work, save, invest and take risks. Consider corporate income taxes. They are imposed on profits, something that firms try to maximize. Income taxes lead firms to adjust to taxes, including changing output and thus income. But a VAT is imposed on value-added. No firm tries to maximize value-added.
4. A simplified VAT is easier and cheaper to administer and collect than personal or corporate income taxes.

Effects on Capital Formation

Income taxes penalize saving, relative to a broad based consumption tax of equal revenue yield. The overwhelming majority of nations, even emerging ones, utilize a two-tier income tax structure. The first tier is an income tax on corporate profits. The second tier is a personal income tax levied on all income of individuals including dividends already taxed at the corporate level, and including income of single proprietorship and income from business partners.

Savings are, in effect taxed twice under such an income tax structure. The base of the corporate tax is corporation profits, after all labor and market expenses are paid but before dividends to individual stockholders are distributed. Then previously taxed dividends are taxed again under the personal income tax. Some of these dividends will be used for consumption, but some portion would be saved. This is what is usually meant by the double taxation of savings under an income tax.

Consumption based taxes do not burden savings. Savings are beyond the scope of such taxes. Thus, a switch from income-based to consumption-based taxes enhances incentives to save, as well as taxpayers' capacity to save. The exclusion from tax, by expanding private savings allows but does not guarantee higher economic growth.

Also, consumption taxes, relative to income-based taxes involve fewer economic distortions in the allocation of capital across different sectors of the economy. Under typical income tax regimes income originating in the corporate sector is taxed twice, once under the corporate tax and then again in the hands of dividend recipients. This distorts the allocation of capital within the corporate sector. Why? Income tax regimes allow deduction of interest costs in determining taxable corporate incomes. But dividends are not deductible. This provides corporations with an artificial incentive to use debt finance, rather than equity finance. This bias in favor of debt finance (issuance of bonds) and against equity finance, encourages overuse of "leverage" – debt in the capital structure of firms. This renders firms more vulnerable to fluctuations of the business cycle. Dividends are paid only when a firm makes a profit. But interest is a contractual obligation. It must be paid to bondholders even if the firm makes zero profit. If interest obligations cannot be met, then the firm goes into bankruptcy. Thus, the structure of corporate income taxes exposes firms to a higher risk of bankruptcy.

These considerations help account for the recent ascendancy of consumption-based taxation such as the VAT in Europe, Canada, Africa and Latin America.[footnote] Even in the United States, widespread perceptions of inherent problems of the income tax led to the emergence, in the nineties, of many influential pressure groups seeking a fundamental shift toward reliance consumption as the tax base at the national level. This will likely never happen in the U.S., for reasons we will soon discuss.
See Malcolm Gillis, (2001), "Tax Policy and Capital Formation: African Experience with the Value-Added Tax", *Policy Sciences*, 34(2): 195-215.

The VAT works best when it utilizes a simple, single rate tax, a flat-rate tax, as in Denmark, Indonesia, and Peru. A single rate makes tax work more smoothly, with less evasion, with less severe economic effects some countries employ multiple rates of VAT, with especially high rates on so-called luxuries. This vastly complicates VAT operations.

In Africa, up until the 1970s, only Cote d'Ivoire, Senegal, and Madagascar (all former French colonies) utilized any form of VAT. The early form of VAT used in these nations was crude relative to the present European-style VAT. Now the VAT has spread over much of Africa, improved versions of the tax now operate.

The producer goods issue provides another example for the attractiveness of the VAT. Examples of producer goods include capital equipment. (More on producer goods later).

Alone among broad-based indirect taxes, only the VAT can be structured to fully relieve producer goods, as well as exports from tax. This feature of the VAT has often proved to be decisive when tax reform has been under consideration.[footnote] As early as 1969, Sweden switched from a single stage retail tax to a VAT precisely to encourage capital formation and exports,[footnote] because of the greater ease with which producer goods and exports can be treated relieved of tax under the VAT. How? When a firm pays any taxes or capital goods it purchases, it can under the VAT, but not other sales taxes deduct these taxes from taxes due on sales.
Even so, there are – unaccountably – several countries that do not permit full and immediate deductions of VAT on capital goods. S. Cnossen, (1998), “Global Trends and Issues in Value Added Taxation”, *International Tax and Public Finance*, 5: 399-428.
Malcolm Gillis (1986), “Worldwide Experience in Sales Taxation”, Policy Sciences, 19: 125-142.

In all nations, a large share (14-28%) of goods is used exclusively as inputs into a business. These are called “single-use” goods, or producer’s goods. There are items purchased by a firm to be used for further production. Example: a furniture firm purchasing a lathe, or parts and materials, machinery, equipment. A consumption tax should not apply to producer’s goods, because the goods are not consumption goods.

The VAT is also likely to be conducive to economic growth in emerging nation for yet another reason: it is a revenue workhorse,[footnote] to finance capital formation of current government operations. The VAT has often been viewed as a “money machine.”[footnote] While this reputation is not fully deserved, it is nevertheless true that a simple flat-rate tax credit VAT can raise more revenue with fewer economic and administrative costs than any other tax now in use.

See Cnossen, 1998, p.413.

The fear that the VAT will in fact result in large revenue increases accounts for the reluctance of many otherwise market-oriented politicians and even economists to endorse the tax. See Gillis, 1986. Liberals, on the other hand, fear the VAT will be regressive. See Charles McLure “Income Distribution and Tax Incidence under the VAT”, in Malcolm Gillis, Carl Shoup & Gerardo Sicat (Eds.), *Value Added Taxation in Development Countries*, Washington, DC: World Bank, 1990. Most economists agree with a flat-rate VAT is in fact the most efficient way to raise revenue. But to some this is not an unalloyed advantage of VAT. They are argue that countries utilizing “more efficient” broad based taxes such as a flat-rate VAT tend to have a larger role for government in the economy. Indeed, the authors argue that less efficient tax systems can improve taxpayer welfare because the system creates additional political pressure for suppressing the growth of government.

The VAT: A Taxonomy

There are many kinds of VAT:

Manufacturing VAT	VAT confined to manufactures. A primitive form of VAT; few exist now
Wholesale VAT	Few examples worldwide.
Retail VAT	The most common type of VAT

Consumption VAT	Where the tax base is strictly consumption
Income VAT	Where the tax base is similar to the base of an income tax. (Rarely ever used).
Tax Credit VAT	Where taxes paid on purchases can be deducted from taxes on sales
Subtraction Method VAT	Rarely used. Where firms actually collect value added

A retail VAT includes retail, wholesale and manufacturing level (all levels are taxable). A retail VAT is the most comprehensive. It is by far the best form of VAT, but it is difficult to use when a country has very large numbers of small retailers. In that case consider a wholesale or manufacturing VAT should be considered.

The VAT most relevant to emerging countries is the one used in Europe for past 30 years, with the following features:

- A VAT employing a Uniform Rate.
- A Consumption VAT, collected through a tax credit mechanism, extending to the retail level but exempting very small firms with poor record-keeping.
- Exports are zero rated (and thus exempt from VAT).
- A VAT extending through the retail level.

Operation of the VAT

Except for very small firms, all sales at all levels are taxable. Suppose the VAT rate is a uniform 19%, as in Peru. A retail clothing store collects 19% tax on all its monthly sales. Does the firm send all this 19% to the government? NO. From taxes due on its sales, the firm gets to subtract all VAT it paid on its purchases, say from clothing manufacturers or wholesalers. The firm taxes a tax credit for taxes it paid on purchases, and then remits the difference to the government. Neither the firm nor the government has to actually compute value added: tax credit mechanism works to tax only the value added by the firm. This is illustrated in the numerical example below.

To begin with, recall value added is the difference between firm's sales and the purchases the firm made during each taxpaying period (purchases from suppliers). Under the tax credit type of VAT, the retail firm in our example does not need to actually compute value-added.

The firm merely applies the VAT it paid on its purchases from other firms against VAT due on its sales. Consider:

> T = VAT to be paid to government by the firm
> t = VAT tax rate
> S = Total sales of the retailer
> P = Purchases from suppliers
> To compute T, the firm merely uses the following relation:
> $T = S(t) – P(t)$
> If the VAT rate is 20%, and sales = 100 and purchases equal 60, then T = 20 – 12 = 8 TOTAL VAT due to government

Because firms would never attempt to maximize value-added, we expect lower efficiency losses from VAT. On the other hand, firms do try to maximize profits, so taxing profits can lead to adverse changes in firm's behavior.

Again, the basic reasons that the VAT has become the predominant form of sales tax worldwide are fourfold. First, the widespread perception that a properly designed VAT can raise more revenue with lower administrative and compliance costs, than other broadly-based consumption taxes, and can do so in highly neutral fashion. And the VAT can also be more effectively enforced than other forms of indirect general consumption taxes.

Second, the retail VAT is more neutral in its impact on private sector decision-making relative to wholesale and manufacturers level sales taxes or income taxes because it does not influence the forms or methods of doing business. Under a retail VAT, the taxes paid on any product or service is the same for one produced in the corporate or non-corporate sector, whether by capital or labor intensive methods. And the VAT, unlike the income tax has no effect on firm’s leverage.

Third, the VAT is also clearly superior in its treatment of international trade: only under a VAT is it, in practice, possible to free all exports from tax, through zero rating of exports, and rebates on VAT previously paid on materials and capital equipment used for export items.

Finally, the VAT is best suited for implementing one of the basic aims of switching to consumption taxation: the encouragement of capital formation. This is because of the marked superiority of the VAT in freeing capital (producer) goods and exports from tax (relative to other consumer taxes).

In sum, a flat-rate VAT is perhaps one of the cleanest, most effective fiscal tools ever devised. But it is very unlikely the U.S. will adopt a VAT in the near future, for three reasons:

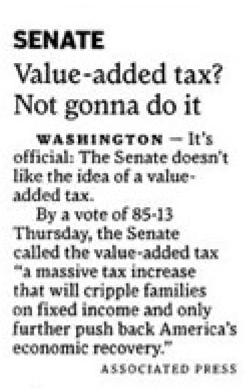
Partisan groups talking past each other.

Poorly informed Conservatives believe that VAT is merely a money machine. They think that it will allow government to grow steadily larger as a percentage of GDP. This belief was widespread in 1986 in U.S. It is still found in 2014 (see WSJ article “Dangers”, Oct. 15, 2009).

In 1984 I was a consultant to Treasury on what was called Treasury I – the study that led to the 1986 tax reform in U.S. – the so-called Reagan Reforms. My assignment was the VAT, contained in Volume 3 of Treasury 1. I was told, “Depict in detail a good workable VAT. Do it for history. We know we cannot adopt it now because of the “money machine” reputation of the VAT.”

Poorly informed Liberals distrust VAT. They mistakenly believe all consumption taxes are very regressive. They fail to understand this is not necessarily so. A properly constructed VAT can easily avoid regressivity by zero rating (i.e. exemptive) food and taxing income elastic consumption of personal services and providing rebates to low income taxpayers.

A final reason 46 states operate retail sales taxes, when consumption is the tax base. States fear federal encroachment on their most important tax base. There has been very strong opposition from this source.



SENATE

Value-added tax? Not gonna do it

WASHINGTON — It's official: The Senate doesn't like the idea of a value-added tax.

By a vote of 85-13 Thursday, the Senate called the value-added tax "a massive tax increase that will cripple families on fixed income and only further push back America's economic recovery."

ASSOCIATED PRESS

Consider that on 160 other nations have adopted VAT, including all European nations. They don't believe the VAT inherently hurts poor people. They understand that it is a good clean revenue source.

SAVINGS, TAXATION AND THE PRIVATE SECTOR

Domestic Private Savings

Capital formation essential for economic growth must be financed by savings from some source: public savings, foreign savings or domestic private savings. Mobilization of public savings requires a well-functioning tax system. We have seen, however, that a part of any increase in public sector savings gathered by government taxes will come at the expense of private savings: as much as 50%, according to some studies. Foreign savings (foreign investment and/or foreign aid) are difficult to mobilize on an ongoing basis. Most countries seeking economic growth must therefore place strong reliance on domestic private savings for financing domestic capital formation.

Components of Domestic Private Savings

We first consider private household savings. Household savings includes savings in unincorporated enterprises (proprietorships, partnerships). In fact, small and medium sized private firms have been a substantial source of investment finance in many emerging nations. In the past few decades – these same enterprises typically provide the lion's share of growth in jobs, as in the U.S., Germany and Korea from 1960-1995. Worldwide smaller scale enterprises were responsible for 80% of employment in the three decades prior to 2010.

Consider the following taxonomy of domestic private savings (recall, saving is simply not consumption).

A. Developed Nations – Domestic Private Savings are dominated by:

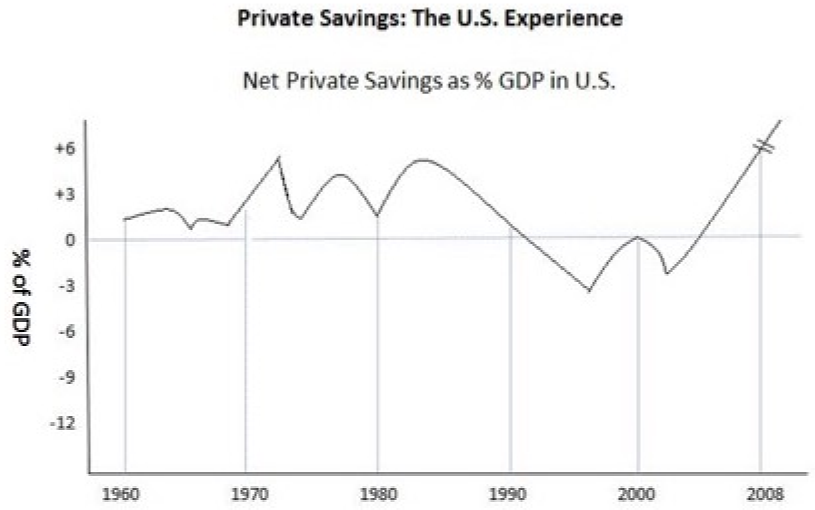
1. Time Deposits (Saving Accounts)
2. Bonds (Debt Instruments)
    - Corporate Bonds
    - Government Bonds

3. Stocks (Equity Instruments)
4. On occasion Social Security. Not in the U.S., because U.S. Social Security system is a pay as you go system. So the U.S. Social Security system is not funded. Systems used in Singapore and Chile are funded and therefore are components of savings.
5. Corporate Savings (Retained Earnings of Corporations). This is Net Income after tax income not paid out as Corporate Dividends).
6. Accumulated Net Wealth in Housing
7. Whole Life Insurance Policies
8. Durable Goods. Physical Assets with useful lives greater than one year.

Developing Countries

Private Savings in emerging nations consist mainly of categories #1, #5, #6 and #7, with some twists. In the past categories #2 and #3 in past (Bonds, Stocks) were not all that important in emerging nations because the organized financial system in emerging nations is not usually that well developed. However with growing capital mobility this is changing. Category #8, durable goods, is interesting. In rich countries one rarely considers purchases of laptops as an act of savings. But it is non-consumption in any context? It generates future income, for many households (not all, of course).

We first provide some perspective on private savings by examining the U.S. experience since 1960.



In some recent years net private savings was negative in the U.S.

2005	-2.6%
2006	-3.8%
2007	-2.4%
2008	+1.6%
2009	+7.7%

So something very interesting happened to private savings in U.S. after 2007. 2007 was the very year the financial meltdown started, beginning the so-called “great recession”. In the U.S. in 2007, net private savings turned positive for the first time in fifteen years. Net private U.S. savings in 2007 were 1.6% of GDP. And in 2008, U.S. private savings, as % of GDP was 7.7%, and rose further by 2010.

And is this good news or bad news? Remember, we are always concerned with total savings – SP + SF + SG =S, because the S is what is needed to finance all forms of capital formation, which makes economies grow. Actually, the sharp rise in net private savings after 2007 is probably mixed news. It came about as a result of households cutting their consumption and paying down debts, because of their pessimistic outlook on the economy (and because of a sharp increase in unemployment). And with the meltdown of financial markets in 2007-2010, many households had less capacity to finance a comfortable future retirement. So they tended to save more.

Indeed, one component of savings household savings rose from 1.4% of Disposable Income (DI) in 2005 to 4.6% of DI in 2009, about a 3.5 times increase.

This sudden and unexpected shift in savings behavior was unprecedented. But shifts can occur in emerging nations too, as we will see.

Theories of Savings Behavior

A theory of savings behavior is also a theory of consumption behavior. Before considering theories of savings behavior we need to consider what is meant by the real interest rate, or more accurately, the real, after tax rate of interest versus nominal interest rate. This distinction will become especially important when we consider financial policy in a subsequent chapter.

The after tax nominal rate (r_t) is defined as

$r_t = r (l - t)$	r = the nominal rate interest
	t = applicable income tax rate

The Elasticity of Savings and the Real rate of interest

What is meant when economists refer to the interest elasticity of savings? Essentially, they are concerned with the response of savings to the real net-of-tax rate of interest (r*), not the nominal rate of interest.

Savers respond to the real after-tax interest (interest adjusted for inflation), r*, which is defined as in equation (1).

$$r* = \frac{(1+r_t)}{(1+p)} - 1$$

p=rate of domestic inflation as a fraction, not a %.

If the nominal after tax rate of interest=10% and if inflation =5% then the real after tax rate interest is 4.8%. If the nominal rate after tax is 10% and inflation is 20%, then the real after tax rate of interest is minus 9.2%. As a result, savers are heavily penalized, and borrowers heavily subsidized

Negative real rates are not uncommon. In recent years the U.S. federal funds rate has been close to zero, while inflation has hovered at about 2.0%. (Note: It is usually permissible merely to subtract inflation from the nominal rate to get the real rate. This is true for lower rates of inflation (say 1% to 5%). But when inflation rates are very high, one must use equation 1 above to find the real rates. Suppose inflation is, say 20%. Then, if r = 10% the real rate is not 20-10, but = 10 – 9.2%.

Many emerging nations have long histories of negative real rates of interest, as we will see.

Now, we define the interest elasticity of savings Er*, to represent the response of savers to changes in the real interest rate.

When returns to savings are interest elastic (Er*>1) and taxable, then savers will respond to changes in the real after tax rate. They will tend to save less when ER*>1, and save more when ER*>1.

The real interest rate will become very important in our discussions of financial systems.

Whether Er* = 0, or is significantly different from zero is important not only for private sector savings mobilization, but for the effects of financial policy as well.

Theory and Empirical Evidence

Until about the mid-eighties, most policy-makers and economists believed that Er* ≅0, where again Er* = Elasticity of savings with respect to real after-tax interest rate. This view is quite consistent with the Keynesian tradition. Recall from basic economics the Keynesian savings-consumption function, given as in equation 2.

$S=a+sY_d$

a=Y intercept

Y_d = disposable income (income after taxes)

s=MPS

In the Keynesian formulation – there in no role for the interest rate in savings decisions. All savings in any year depend only upon disposable income (y_d) in year t – i.e. savings depend only on current income.

And the Duesenberry relative income hypothesis depicted also allowed for no rule for interest rate[footnote], as the Duesenberry hypothesis was directly in the Keynesian tradition.
See Gillis, Perkins, Snodgrass (5th edition), New York, NY: Norton Publication, Chapter 13.

However, post Keynesian savings functions, do allow for a role for interest rates. To illustrate consider the MBA hypothesis (Modigliani, Brumberg and Ando, 1963). This is the Life-Cycle hypothesis.[footnote] For the economy as a whole equation 3 presents one form of a life-cycle aggregate savings function:
See Gillis, Perkins, Roemer and Snodgrass (5th edition), Chapter 13.

$$\frac{S}{Y} = a + b_1 H + b_2 U + b_3 W + b_4 D + b_5 r^*$$

a = y Intercept (autonomous consumption)

H = Rate of productivity growth

U = Life expectancy

W = Societal Net Wealth (assets minus liabilities)

D = Dependency ratio (the ratio of dependents to the working age population), and finally

r* = the real interest rate

So, the life-cycle hypothesis has a role for the real interest rate.

Another, very influential aggressive savings function has been Friedman's permanent income hypothesis. This is interesting for emerging nations especially. It also includes a term showing a positive relationship between real interest rate and savings decisions.

Friedman's permanent income hypothesis is depicted in equation (4).

$$S = a+b_1Y_p+b_2Y_t$$

Where a = a constant (y intercept of savings independent of Permanent Income)
Y_p = Permanent income b_1 is a parameter on Y_p
Y_t = Transitory income b_2 is a parameter on Y_t
This is a useful hypothesis for many purposes.

The basic point is that people make their savings decisions over a long time horizon that includes their whole life span, just as in the MBA life-cycle hypothesis. Current income plays no role in savings decisions.

We may define in detail the concept. "Permanent Income." This contribution came from Milton Friedman, Nobel Prize winner who spent his entire career at Chicago. He died at age 94, still writing up to the month he died. In a survey of economists, Friedman ranked as the second most influential economist in the 20th century (after John Keynes).

Permanent income is not merely expected lifetime earnings. Rather, it is the expected lifetime yield from a person's stock of capital, including both physical and human capital. Keynes, Duesenberry and the MBA hypothesis all ignore Human Capital. Friedman did not. This is not surprising since Human Capital theory was first conceived by at Friedman's colleagues at the University of Chicago.

Do people really behave this way? To a great extent, yes (worldwide). Consider if person (A) has saved 100K (stock of wealth of 100K) and has a junior college education, he/she will have a general expectation of his/her income over lifetime. If person (B) has saved 250K and has a MA in Computer Science, he/she would expect to have much higher lifetime earnings than person (A).

Now what is transitory income? This is nonrecurring or unexpected income, such as lottery winnings, windfall gains, gains arising from increases in the value of your assets (such as housing assets), or for a nation or individual windfall from an increase in export earnings.

A major point about permanent income hypothesis. In its polar version,

$b_1 \cong 0$ (little savings out of permanent income over time).

And $b_2 = 1$(all transitory income is saved).

Nowadays, we reject those values. Rather most economists believe that some savings does occur out of permanent income, and not all transitory income is saved.

That is to say: $0<b_1<b_2<1$

Because permanent income does depend on the yield from accumulated assets (including Human Capital) it also partly depends on the interest rate. So in the permanent income hypothesis. Unlike the Keynesian hypothesis, there is a role for interest rates in influencing savings. One might view parameter b_1 as in expression (5) below:

$$b_1 = c_1\left(\frac{w}{yp}\right) + c_2\left(N\right) + c_3\left(r^*\right)$$

$\left(\frac{w}{yp}\right)$ ----Wealth as a proportion of y_p, where Y_p = permanent income

N ---- Socioeconomic variables (life expectancy etc.)

r* ---- Real interest rate

Always, in these formulations the interest rate must be viewed as the real after tax rate of interest. Friedman, however originally did not think that the interest rate was a particularly important determinant of saving. However at a conference in Monterey, shortly before his death, shifted his view a bit on this point.

Empirical Evidence on interest elasticity of savings

There are few reliable empirical estimates for emerging nations. Three important studies in the U.S. in the 1980s concluded as follows:

Wright 1985	$E_R^* = 0.2$
Michael Boskin (Stanford) 1980	$E_R^* = 0.4$

In the Boskin formations, a 10% increase in the net-of-tax interest rate would 4% increase in put-savings.

Larry Summers (Harvard) suggests a long-run interest elasticity of 2.0, indicating a strong response for savings to the real interest rate.

For emerging nations, there is little real systematic information but E_R^* has tended to be higher in countries with positive after-tax real rate interest.

From this brief discussion, we might conclude that:

1. E_R* is definitely not zero
2. E_R is probably not higher than 0.32 in medium term, perhaps 0.5 in the longer term
3. Policymakers do have to be concerned about impact of taxes on savings on growth of aggregate savings

   Also, for later reference,
4. Interest rate controls usually reduce savings, especially in the face of inflation, because they reduce the return to savers

When governments hold the nominal deposit rate of 12% and inflation is 20% the real interest rate is a negative 8%. Savers may be expected to respond to this incentive by saving less, but how much less? A precise answer is not likely, but the impact would not be trivial.

Another Look at Household Savings in China

For example, we have earlier discussed some of the reasons why the savings rate in China was so high from 1990-2015. We have seen that high business savings (retained earnings) has been part of the answer. But, household savings have been huge, as Chinese gross savings hovered near 50%. Net savings (gross saving – depreciation) was around 40% - and households have been saving about 25% of their income. Why? In addition to the previous 12 factors cited earlier, we may also look to the MBA and Friedman life cycle savings hypothesis.

In the MBA hypothesis, consider b_1, the parameter for productivity growth, and therefore income growth. Perhaps Chinese households have saved so much is because their incomes have grown so fast. The Friedman permanent income hypothesis also sheds some light on the matter.

Have most Chinese been treating their very rapid income growth as transitory income? Has income been growing so fast that peoples consumption habits haven't caught up? Did Chinese households believe that

GDP growth would eventually slow down? That would lead them to save more.

The MBA hypothesis may provide yet another for high savings rates in China. There has been a drastic fall in the dependency ratio due to the one child per family policy. Economic theory has long held that a fall in the dependency ratio would lend to a rise in savings rates because with fewer dependents to support a family can save more.

The Nobel Laureate A.K. Sen cites the possibility of a “million missing women” in China from 1990-2010.[footnote] Perhaps China’s rising sex ratio imbalance is contributing to high savings rates – “too many boys” relative to girls at birth, due to strong son preference and frequent abortions of girls. This sex ratio imbalance may have caused Chinese households to postpone consumption (i.e. save), so as to accumulate wealth – why? With a shortage of females, some men may face a future of long-term bachelorhood. So the hypothesis goes, families hope to avoid the risk that sons will be perpetual bachelors, and this will increase their savings rates.
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Higher wealth for sons, it is hypothesized make sons more attractive to increasingly scarce brides. Also households with daughters do not reduce their savings rate. Empirical studies at NBER confirm that this effect is stronger in rural areas, where son preference is stronger than in urban areas. [footnote] According to one study by Wei and Zhong, the increase in the male/female sex ratio accounts for half of recent increases in household savings in China. Not everyone would agree that this effect is so large, but it is worth considering.
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Business Savings

We may now expand our discussion on business savings.

Recall, business savings is of 2 types:

1. Retained earnings of corporations,
2. Savings from income of partnerships and single partnership.

The second component of business savings is already counted in household savings and should not be double-counted.

Corporate savings proper are retained earnings of corporations, as defined below. We begin with GROSS INCOME. Then we subtract three items to find retained earnings.

- Expenses (including depreciation)
  Net income
- Corporation Taxes
  After tax income
- Dividends (if any)

=Retained Earnings

Retained earnings in many nations, including poor ones, has sometimes the most important service of private savings. In 21st century China, retained earnings of State-Owned Enterprises (SOEs) have been a very important source of saving.

Clearly, taxes on corporate income decreases retained earnings in the private sector. A major reason for worldwide tax reform between 1981 and 2001 in both rich and poor nations was the desire to increase private savings by allowing for more retained earnings and thus more private sector savings. Virtually every nation that instituted major tax returns in that period reduced corporate tax rates.

In some cases, corporate tax rates were reduced from 60% to 15%. More usually the reduction was from 50% to 20-25%. In a world of highly mobile capital, so many other countries reduced corporate tax rates that the U.S. by 2014 had the highest corporate tax rates in the developed world. And the U.S. rate is higher (35%) than all but a small handful of poor nations.

Chile is one example of a country that sharply reduced corporate tax rates in the 80s. In 1984, this nation reduced corporate tax from 50% to 10%. Subsequently, and as a result, empirical studies show, there was in Chile:

1. An immediate large increase in business savings, because with lower corporate-tax rates, retained earnings increased,
2. A very large increase in private investment, actually an investment boom.

In first year after the slashing of Chilean tax rates from 50% to 10%, investments grew by 4.5%. And the increase over the next five years was even more impressive. The ratio of investment to GDP in 1984 was only 15%. Hardly enough to sustain growth at even 2% year. By 1989 this ratio had increased to 25%, sufficient to support economic growth at 7-8% year.

The Chilean experience was repeated in Indonesia between 1984 and 1990 and in several former socialist nations after breakup of the Soviet Bloc after 1991 (Latvia, Estonia and Lithuania).

We now turn to a consideration of major analytical questions in relation to taxation, savings and capital formation.